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PIPE LINE INDUSTRY

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Boys

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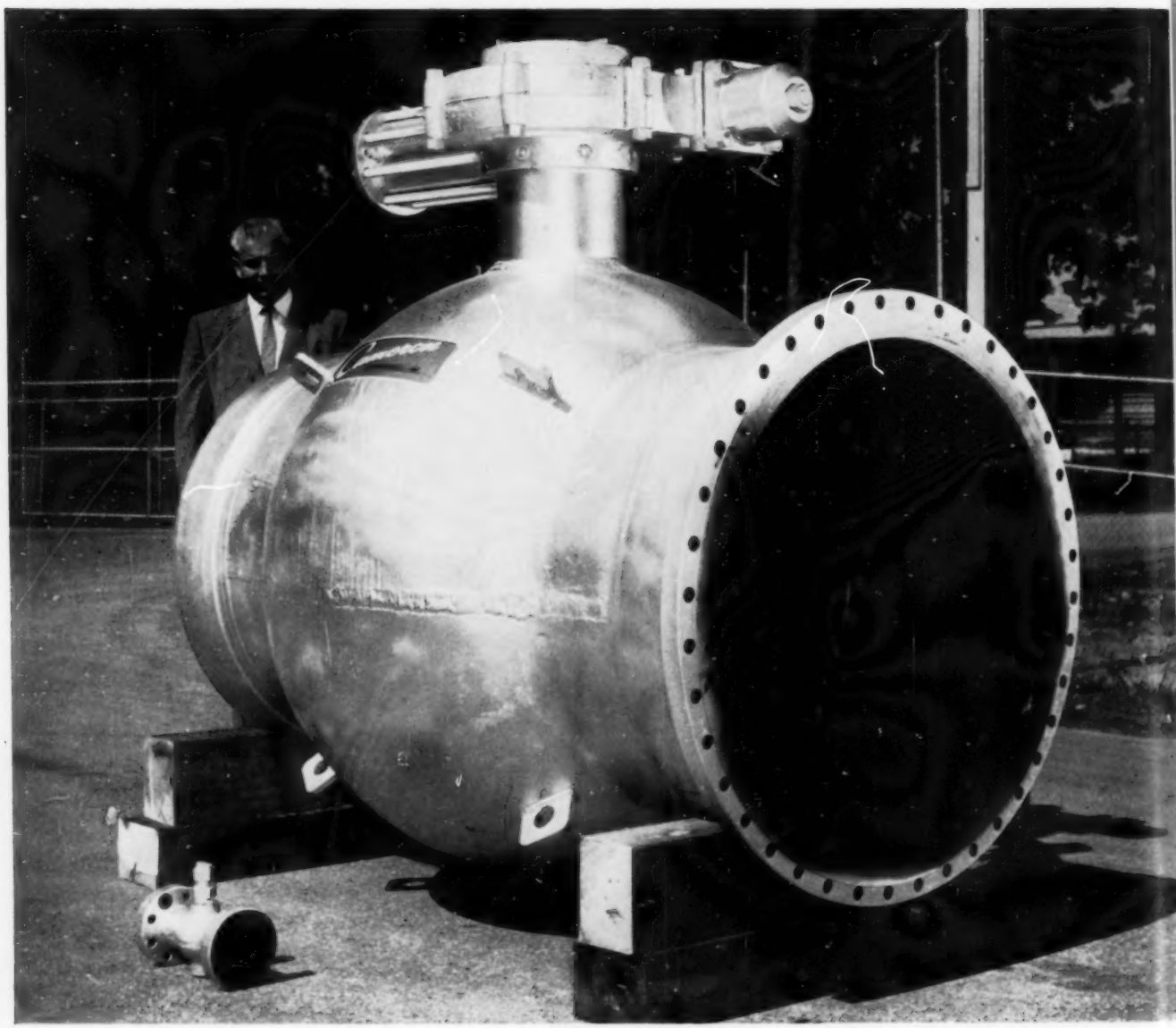

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PIPE LINE INDUSTRY

A GULF PUBLISHING COMPANY PUBLICATION

July 1961 Vol. 15, No. 1

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and Quick Look

To help you put first things first, scan these time-saving digests, checking ✓ those you want to read first.

New Design Makes the World's Longest Aerial Pipe Line Suspension Span Possible

☐ By clamping the pipe directly to the main supporting strands, engineers solved the problem of sway and undulation. They have found that tension keeps the pipe in line. This bridge across the Missouri River measures 2,703 feet from tower to tower! The north tower which is 273 feet tall is believed to be the world's tallest structure to be erected in one piece.

Donald M. Taylor ..... Page 40

Storing Gas in an Abandoned Coal Mine

☐ This may prove superior to other methods involving storage in sand or limestone pores. The gas is more readily recoverable and less subject to contamination. Public Service Company of Colorado has taken over the Leyden coal mine near Denver, sealed the shafts with water and stored up to 750 MMcf in it. Now the company is in the process of sealing the shafts permanently. Hoped for ultimate storage: 3 billion cubic feet.

Robert E. Kelly ..... Page 46

Sinclair's One-Man Engine-Driven Station Saves Money

☐ The station has two 2000-hp dual-fuel diesels which are ideally suited to the fluctuating load. Automatic controls make it possible for one man to operate the station easily. All pumping is from tankage and at most times is high-volume batches of crude.

..... Page 51

Deep Freeze Solves Problem of Limited Pot Life of Internal Sealant

☐ West Texas concrete-lined steel pipe line had to have internal seals at joints left for the welding. The best sealant for the job had to be mixed with a catalyst and once mixed, it had a limited pot life. The pipe line contractor solved the problem by quick-freezing the material and hauling it to the job in daily batches

..... Page 54

What You Should Know About Cavitation and NPSH To Make an Economical Selection of a Pump

☐ In recent experimental work, a relationship between pump suction characteristics and fluid properties was worked out. The data collected and the theory developed aim at accurate prediction of pump suction requirements for all liquids, on the basis of cold water requirements.

Victor Salemann ..... Page 55

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Will You Be Worth as Much 10 Years From Now?

"THE REASON starting rates creep up on salaries paid to more experienced engineers is because recent graduates are worth as much or more than many older men," . . . these are the words of Dr. Thomas Stelson, head of the civil engineering department of the Carnegie Institute of Technology quoted in the National Society of Professional Engineers *Newsletter*.

If newly hired college graduates have the temptation to throw out their chests and pity us "old timers" who have been working in the industry for upwards of 10 or 15 years, they will be brought back down to the rugged earth by his next statement . . . **"unless engineers devote a considerable portion of their time to keeping abreast of their field, they quickly are left behind and lose their value to industrial employers."** Basing his estimate on changes in the Carnegie curriculum over the past ten years, Stelson says that **an engineer who wants to increase his value at a reasonable rate has to devote about one-third of his productive hours to self-education and improvement.**

Further, Dr. Stelson notes that there are many individual cases where engineers wind up unemployed or working in sub-professional capacities because of obsolescense, and he thinks the situation is becoming worse. "Such a trend implies that a new engineering graduate is near the peak of value to his employer and society and that several years of experience may only add slightly to his professional stature." The problem will get worse, he concludes, "unless professional societies, employers, and schools recognize its importance and develop suitable remedies."

Stelson's recommendations include: improvements in undergraduate training, increased emphasis on graduate education, better on-the-job training, study leaves, and exchanges of ideas through professional societies.

. . . To this we would add one more . . . regular reading of engineering and technical magazines carrying articles with depth, plus the best new technical books covering your field and if you'll forgive a pause for a word from our "sponsor" here is where we come in. One of the best ways to keep up with new developments as they break in the pipe line business is through regular reading of responsible technical industry magazines (e.g. PIPE LINE INDUSTRY). The work of our staff, and many capable industry authors, plus hundreds of other contacts through them can provide the regular reader a lot of information he needs in a fraction of the time it would take him to attend the meetings himself or to make these industry contacts directly.

This time of year while we listen to graduation speeches and get ready for welcome summer vacations, it might be very well for recent graduates, and the not so recent ones, to ponder the fact that all of us have a continuing education job to do; starting with ourselves . . . now!

Two pertinent comments at meetings just this past month come to mind. At the AGA Transmission Conference in Denver, Dr. W. Orr Roberts of the University Corporation for Atmospheric Research gave the quote **"Science never makes life simpler, it only makes it more complex"** in discussing the implications of long range weather research and control. And herein lies the need for *continuing* study for everyone . . . and most especially the engineer, pipe line executive, technical man, and every industrial employe.

"I don't know about you, but I am going to go to a school and learn how to push that button." Ben Montgomery, vice-president of Crose-Perrault Equipment Corp., at the Houston Pipeliners meeting passed along this quote of a welder to his helper after watching one of the fancy new automatic welding machines on the firing line in the Pacific Northwest.

In a variety of words this idea is being discussed from Denver's AGA Conference to Washington and even to the West Coast pipe line spreads. Of course the solution to the problem isn't this simple but retraining of employes and advanced training of professional people is becoming a must for the pipe line industry.

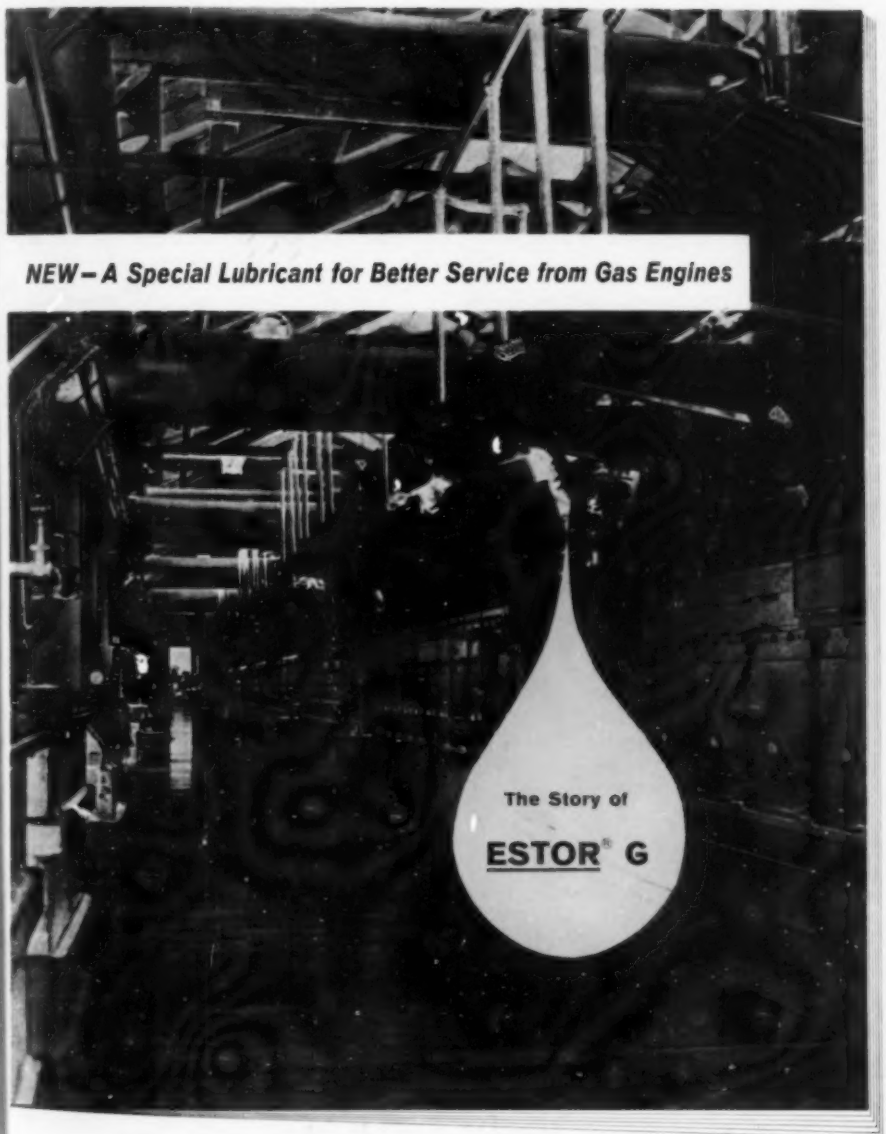
Educator's view. After nailing this editorial together, we went around the hall to consult with our own learned educator, Dr. John McKetta, Jr., Editorial Committee Chairman of our city cousin, HYDROCARBON PROCESSING AND PETROLEUM REFINER, and Chairman of the Chemical Engineering Department at The University of Texas.

"There is too much obsolescence of knowledge among technical men, I agree; but it is an exaggeration to say that newer graduates are better men than the older experienced ones. These newer graduates may have a better fundamental education than the one we received 10, 15, or 20 years ago, but you cannot underestimate the value of actual experience on a particular job. More reading and studying for the man in the field is a part of the answer. In fact, this is a good way for him to regain an advantage over the 'bonus salaries' often being paid to new graduates, because the student in college usually has little time to get the practical side of industry developments," adds McKetta.

So let's pick up the magazines and books and start the rapid reading courses, old timers . . . and you smart new men, too.

Melvin A. Judah

Announcing . . . HUMBLE GAS ENGINE OIL ESTOR® G



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The booklet at left, summarizing findings of Humble engineers in developing and testing ESTOR G, is important reading for everyone who buys, operates, maintains or services heavy duty gas engines.

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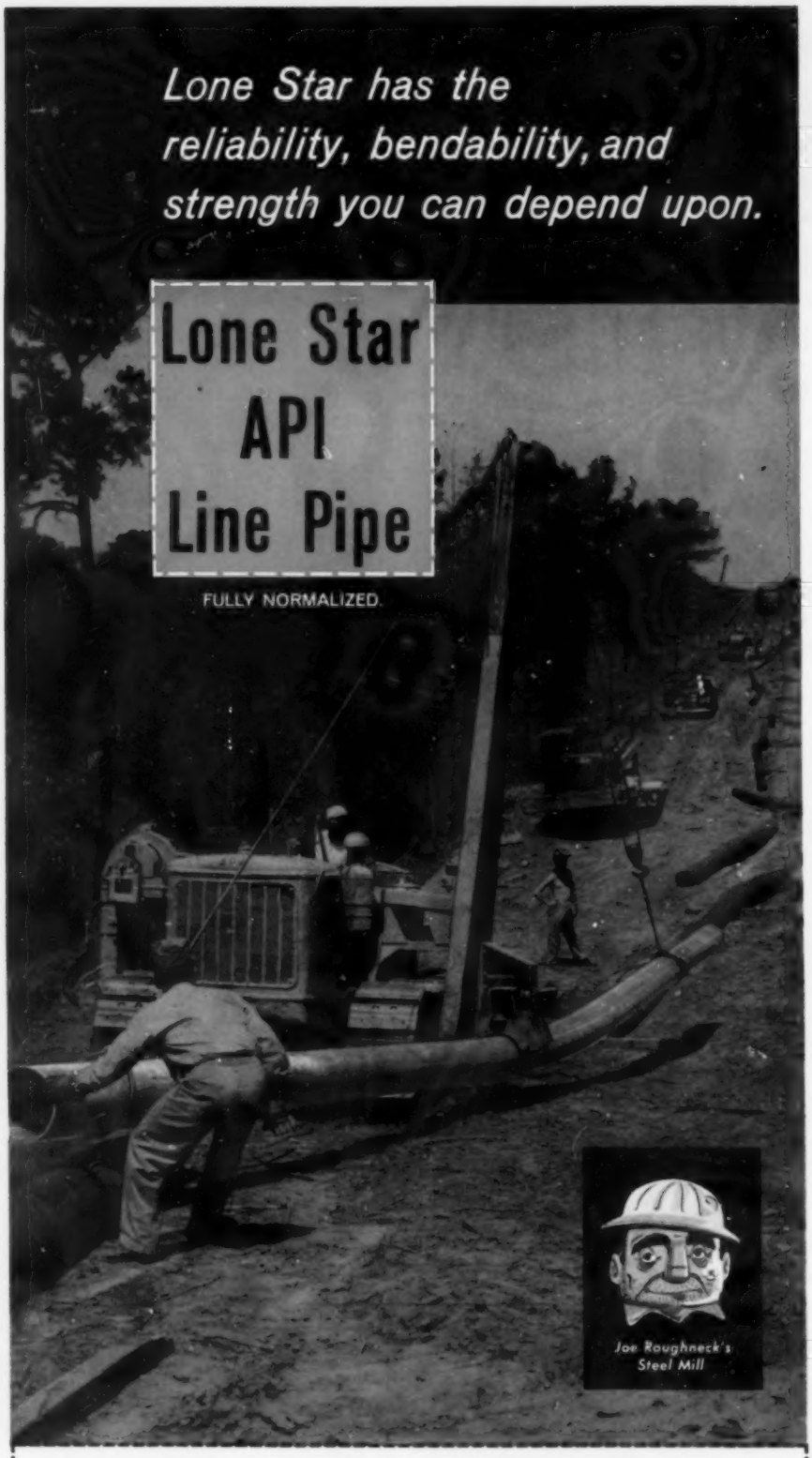
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PIPE LINE INDUSTRY and The PIPE LINE CATALOG for the oil and gas pipe line industry.

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Indexed by Engineering Index

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Take a tip from this contractor...

TRADE UP AND MAKE MORE PROFIT

New D6B Tractors do work 30% faster— cut fuel costs for Carl Rumage

Working in rain, this new D6B Tractor digs a salt water pit 40 ft. x 75 ft. x 10 ft. In spite of slippery ground and exceptionally tough, sticky soil, the tractor will finish the job in a single day. Mr. Rumage keeps his equipment moving — handles soil conservation work when not busy in the oil fields.

Like most contractors today, Carl Rumage, owner of C. A. Rumage Co., Vernon, Texas, is fighting the squeeze on profits every way he can. He's found one of the best ways is to trade up for new, more productive machines—even if existing equipment is working fine. Two new D6B Tractors, recently purchased by this contractor, provide a good example.

Comparing the new D6 with the old D6, Carl Rumage says, "Our new machines do the work at least 30% faster . . . and they do it on less fuel! Trading up to the new D6 is sure paying off for us."

There's good reason for Mr. Rumage's enthusiasm. The new 93 HP Cat D333 Diesel Engine, for example, has 25% more lugging ability than the previous model. A more comfortable operator's compartment and convenient controls help keep operator efficiency high. A new hydraulic bulldozer, with quick-drop valves, gives faster operation, increased productivity.

The new D6B helps keep down operating costs in several ways. Its easy-breathing Cat Engine can operate on high-energy, low-cost fuels such as No. 2 furnace oil. It has a dry-type air cleaner that eliminates the expense and bother of handling filter oil, can be serviced in five minutes, and keeps 99.8% of air-borne dirt out of the engine.

The long-life Caterpillar oil clutch usually gives up to 2000 hours of service before it even needs adjustment. Lifetime lubricated rollers that never need attention until rebuild time are a real convenience and save in maintenance costs.

Trading up to new, more productive D6B Tractors certainly made sense for Carl Rumage. A similar trade may help solve your profit problem. Your Caterpillar Dealer can help you decide and can demonstrate the production advantages of new Cat-built machines. See him today.

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

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ROTA-SCREW

—compression with a jet-age twist

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You just can't beat this rock drilling team for quality, performance and durability. For years pipeliners have seen Gardner-Denver rock drills prove themselves in the toughest of rock. Now Gardner-Denver Rota-Screw compressors join the team to bring you the greatest efficiency yet—in any rock, over any terrain.

Instant compressed air! Flip a switch to start; turn knob for immediate warm-up. Flip a switch to stop—automatic blowdown for quick relocation up ahead.

All-climate performance! From the Arctic to the Tropics—40° below to 115° above zero.

Travel over tough terrain! Extra-heavy-duty frame, reinforced running gear construction, automotive-type steering and heavy-duty truck tires—all designed to take severest punishment of the most rugged ground—and move fast over the road.

Off-level operation! Oil circulating system permits operation on angle—uphill or down.

Pulsation-free air flow! Continuous delivery of compressed air in a new, efficient manner . . . vibrationless operation.

Special Caterpillar engine! New diesel prime mover lowers maintenance cost, provides greater over-all economy, increases horsepower. Rota-Screw 900 cfm compressor uses Caterpillar engine Model D343T; compressor with 600 cfm capacity uses Caterpillar engine Model D333T.

Lowest maintenance ever! No touching parts in compression chamber. No valves. No pistons. No blades to inspect or replace.

*T.M.

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Alignment-compensating coupling—Shock-absorbing rubber blocks transmit power smoothly from the engine to the compressor. Drive compensates for limited angular and parallel misalignment caused by movement over rough ground.

Combined 3-in-1 circulation system—Air receiver, oil reservoir and oil separator contained in one compact vessel—enclosed entirely in Rota-Screw housing.

Deaerating radiator—Removes air from water system to provide a solid stream of water for cooling the compressor oil and the engine.

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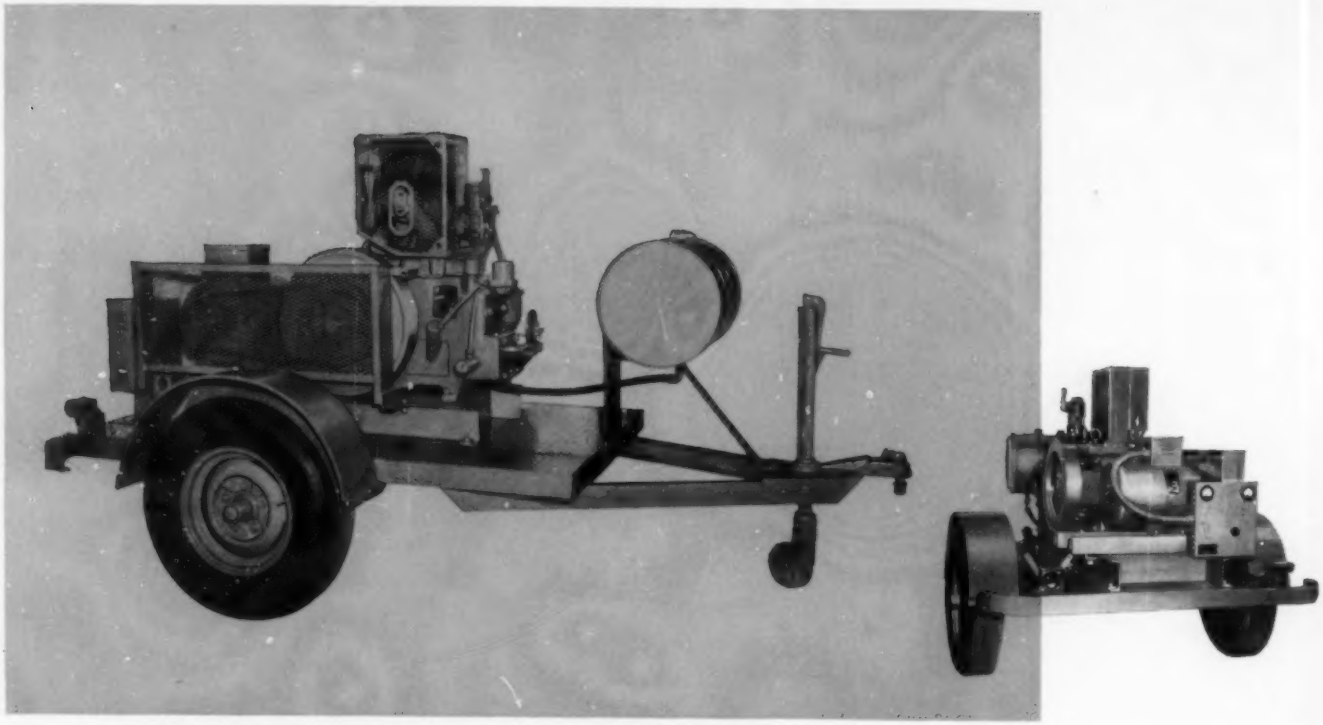

Witte's 98RBD trailer-mounted engine-generator unit has a standard 3 KW DC shunt-wound generator in a wide speed range from 750 to 1800 rpm.

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Complete information on both the standard and trailer-mounted Witte gas engine-driven generator units is available through oilfield supply stores.

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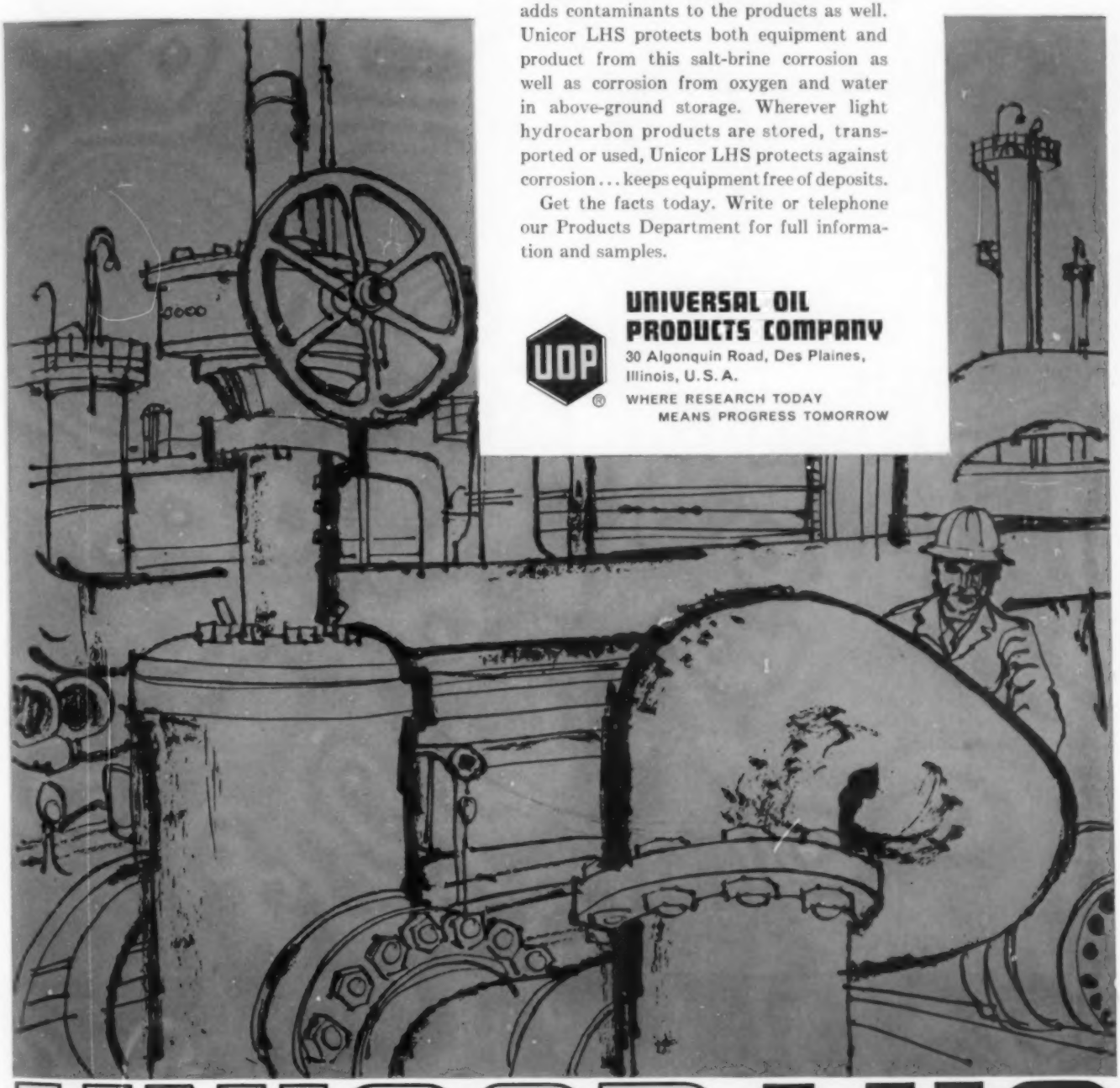

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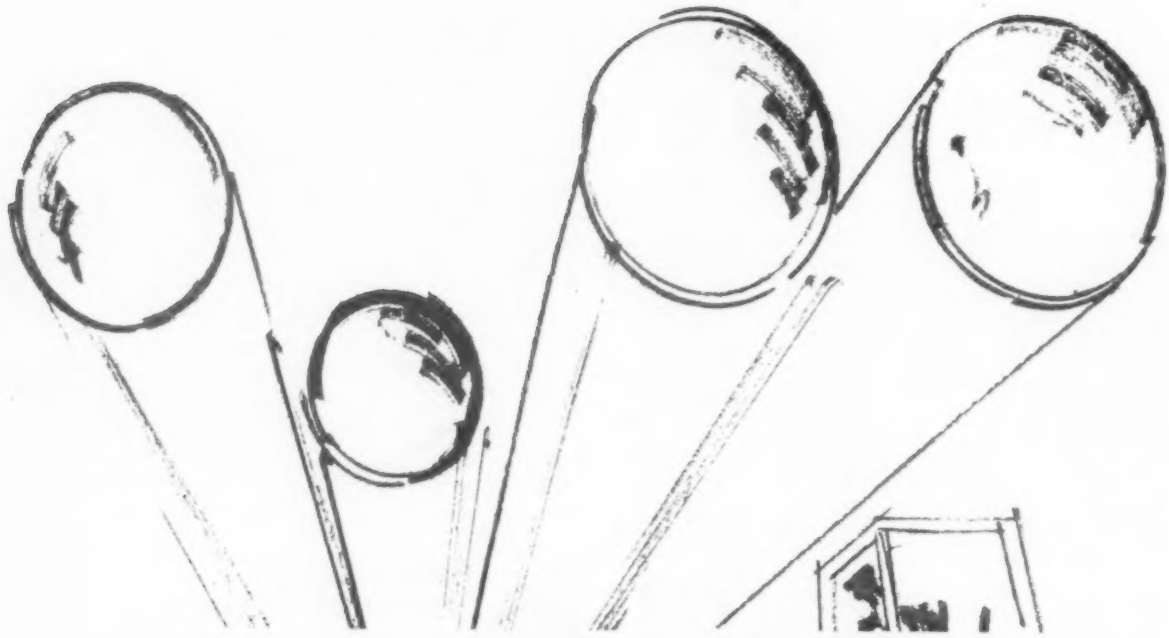
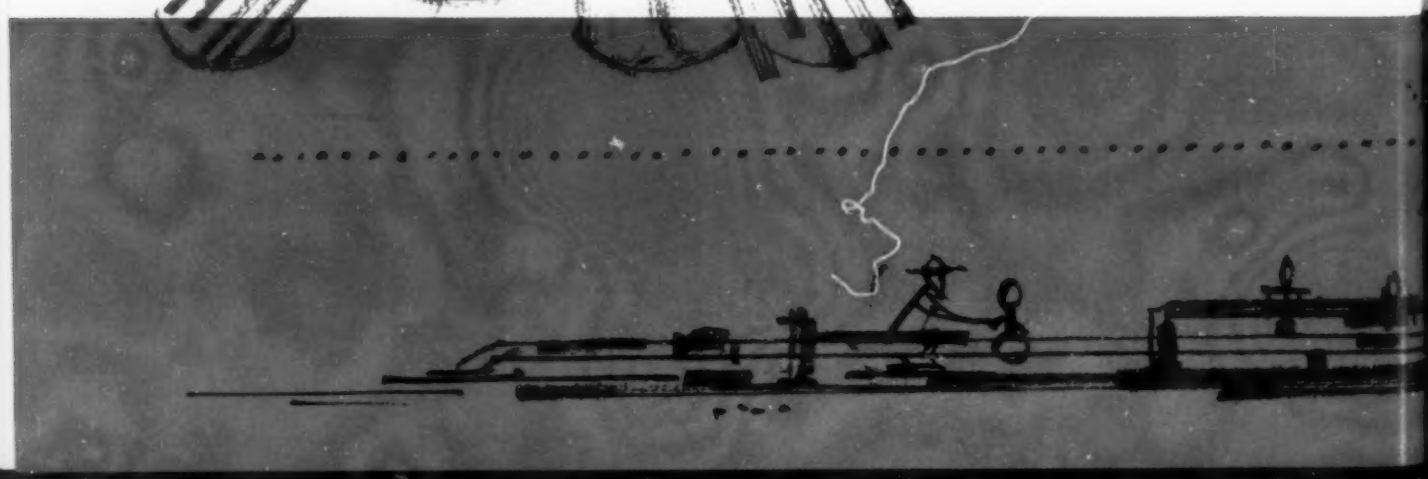


Wherever pipe lines go . . . .



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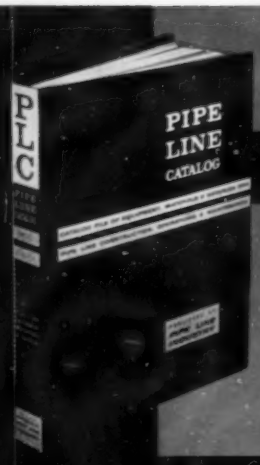

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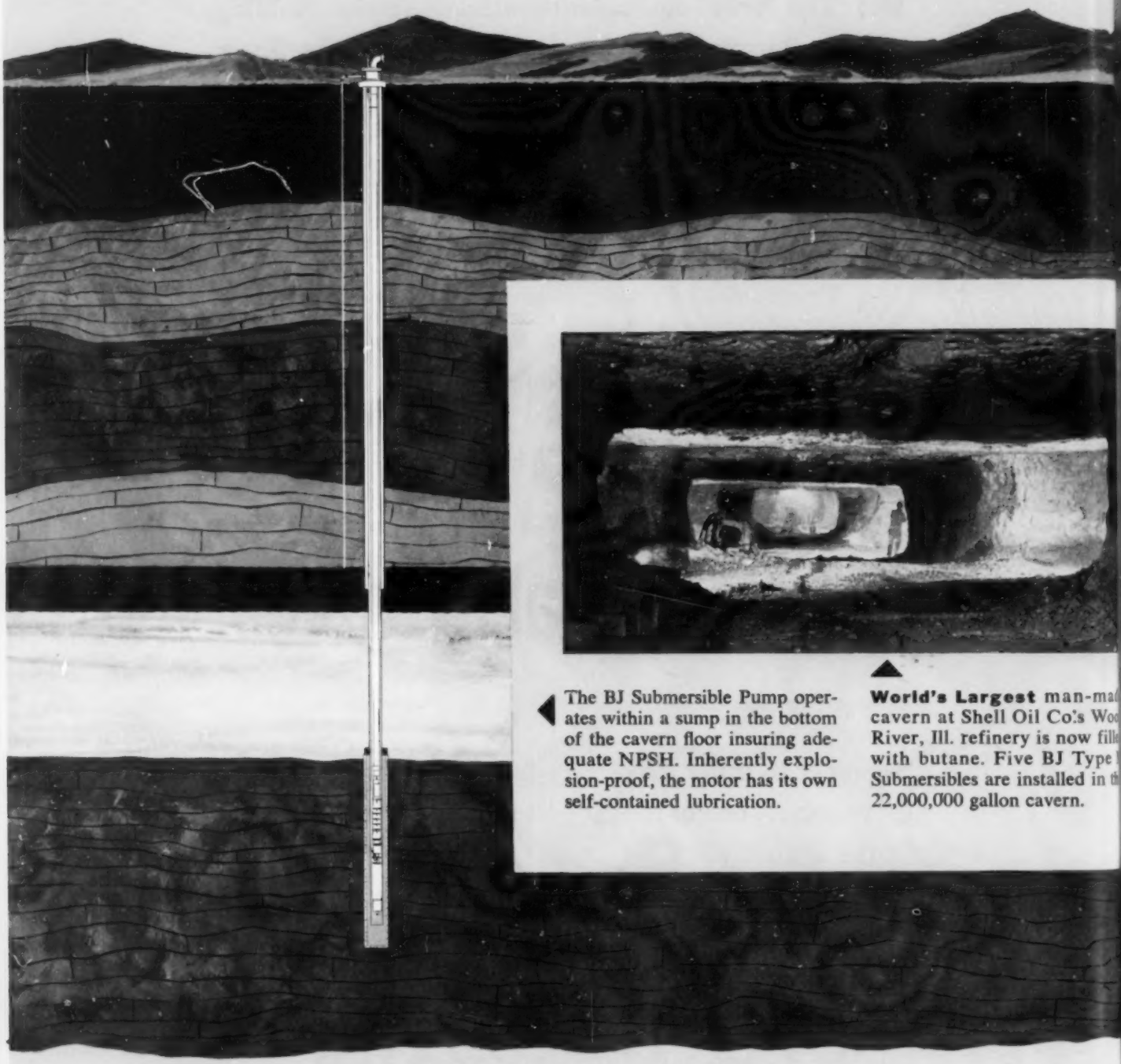
BJ Submersible Pumps for Underground Cavern Storage.



The BJ Submersible Pump operates within a sump in the bottom of the cavern floor insuring adequate NPSH. Inherently explosion-proof, the motor has its own self-contained lubrication.

World's Largest man-ma cavern at Shell Oil Co.'s Wo River, Ill. refinery is now fill with butane. Five BJ Type Submersibles are installed in t 22,000,000 gallon cavern.

Underground cavern storage of Liquid Petroleum Gases has not only proved practical, but economical (approximately 20% of the cost of conventional surface storage).

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Sizes of these BJ Submersibles range from 4 to 16 stages, delivering from 40 to 800 gpm and rated at from 25 to 200 horsepower.

For a technical bulletin giving complete information on pump selection, installation and construction, plus a list of users, call or write BJ today!

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SUBSIDIARY OF BORG-WARNER CORPORATION
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BYRON B-W JACKSON
BORG-WARNER

BANTAM C-350 cleaning out ditch at road-crossing approach before lowering in 12″ gas line.

handiest rig of all around pipeline jobs!

Here's the crane-excavator that's Johnny-on-the-spot anywhere it is needed, any time! The BANTAM C-350 crawler, for example, offers more trenching and excavating ability for its practical, permit-free size than ever before available.

This pipeliner's rig has all the needed features for this work—to speed up all kinds of jobs in the field or confined areas. BANTAM's low ground bearing pressure (less than 3 lbs. per sq. in. with 32″ pads) with resulting high flotation means you work in the wettest going.

BANTAM's simplified mechanical controls deliver fast-action response and trouble-free performance year after year. With BANTAM you get such important extra benefits at **no** extra cost as 2-speed, independent travel for simultaneous lift, swing and travel . . . anti-friction bearings throughout . . . biggest brakes and clutches . . . more rugged design.

Dig 100′ of 5′ trench per hour, dig down to 18′10″ with the C-350 BANTAM's optional, long-boom back hoe. BANTAM sets you up to handle virtually any lifting, loading, excavating, erecting job with BANTAM's 11 fast-change attachments.

BANTAM T-350 cleaning out rock fragments and cutting ditch along paved street for 6″ gas main. BANTAM has a size advantage in congested-area operations, yet is ideal for all field operations.

BANTAM T-350—most popular truck crane-excavator its size in America; preferred because of its rapid mobility and exceptional work speed and range. Big 11-ton lifting capacity; tools up for more pipeline jobs with 11 versatile attachments. Choice of five BANTAM-built carriers.

SCHIELD Bantam Co.

201 Park Street, Waverly, Iowa

World's largest producer of truck crane-excavators

PC-324

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- ☐ carrier-mounted T-350 BANTAM
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- ☐ new BANTAM Compact 250 5-ton, carrier-mounted shovel-crane

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—on Sharman, Allen, Gay, and Taylor pi

Backfiller
4-inch flood
pipeline job

Note that the long boom permits pulling in the clay spoil bank first—then casting board farther to bring in top black soil "spoil," for topping out the ditch. High boom clearance allows in-haul cable to come in above tracks—no dragging through mud means longer cable life. Job: Sharman, Allen, Gay and Taylor, laying 56-mile section of dual line, Seadrift to Texas City.

This 150-B Backfiller beats "hip-boot" conditions to get the spread going after a flood. Even in "soupy" going, precision-lapped, metal-to-metal full floating seals prevent grit and water from "doing dirt" to the 1,000-hr. lube-interval Dura-Rollers.

A four-inch downpour flooded the old ricefields which this line crosses. Before the lowering-in of pipe could be resumed, the contractor had to pump out the ditch.

To control water for the pump-out crew, this new International Superior 150-B Bucket Backfiller forms water "checks" in the ditch at regular intervals—with a few boards-full of spoil dirt.

Balance helps this new backfiller "plow" across swamp and backfill ditch for Sharman, Allen, Gay, and Taylor. Mounting the draw-works on the right-hand side counter-balances the boom—prevents miring down or tipping.

Flotation traction and clearance help the 150-B keep "navigating"—even in extreme bog conditions. There's 98 3/8 inches of track length on the ground, 24 inches of width if needed—for flotation and grouser grip.

Your operator pivots the seat to face the ditch when yo-yoing—or look ahead, traveling. His feet steer this backfiller with hydraulic power—his hands are free to keep yo-yoing. Twelve speeds forward or reverse, from 28-feet per minute up to regular tractor speeds, save time, add capacity. This is the only tractor-mounted, one-man-operated backfiller on the market!

And your operator has no "hot clutch time-outs"—cone clutches are eliminated! New positive clutches run in oil. No excessive heat even in steady, heavy backfilling!

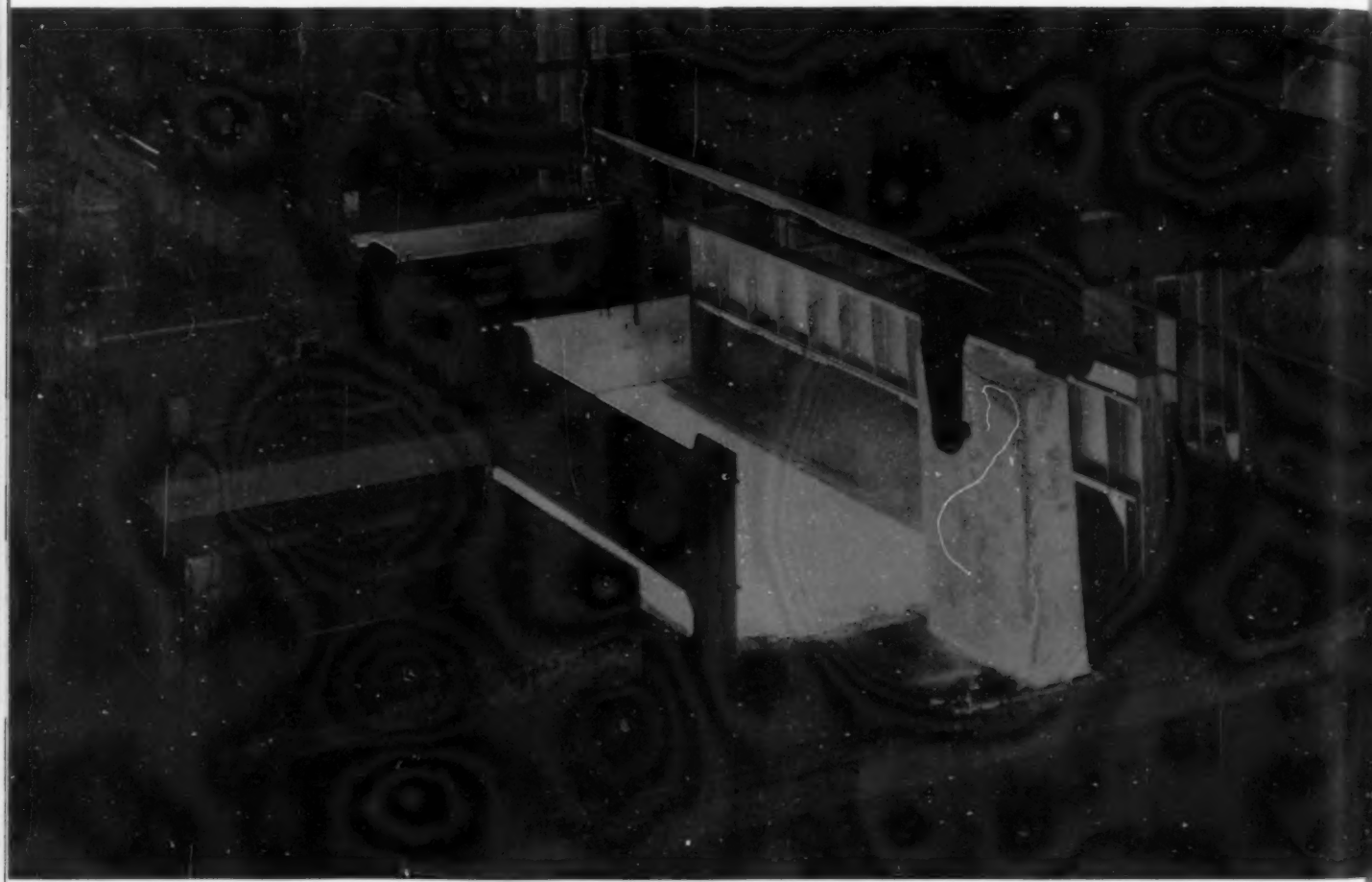
See the new International Superior 150-B Bucket Backfiller on the job. Compare boom reach—size-up dirt-into-ditch capacity with 16 to 20 passes a minute. Measure operating and upkeep ease—maintenance economy. Prove that the 150-B gives you an unequalled combination of features to beat pipelining conditions as they come. Let your International Superior Distributor demonstrate.

International Harvester Company, Chicago 1, Illinois

INTERNATIONAL®
SUPERIOR®

WE'VE GOT IT MADE . . . *Almost!*

SEVEN TONS OF ELECTRIC WELD LINE PIPE



Sure, it still looks like cake from the inferno. But into this seven-ton ingot already have gone the most critical ingredients of pipe making . . . those hours in the steelmaking furnace, where quality is born through precise accumulation of raw materials, skillful control and numerous analytical checks. Next come rolling to exact gage, pipe forming, electric welding, hydrostatic testing and end preparation. Then an electric eye to scan the entire surface, to be doubly sure the pipe meets all requirements of customer, API and ASTM. Quality, location and service make Acme-Newport your logical source for 4″ and 6″ sizes, standard or thin wall. Call us!

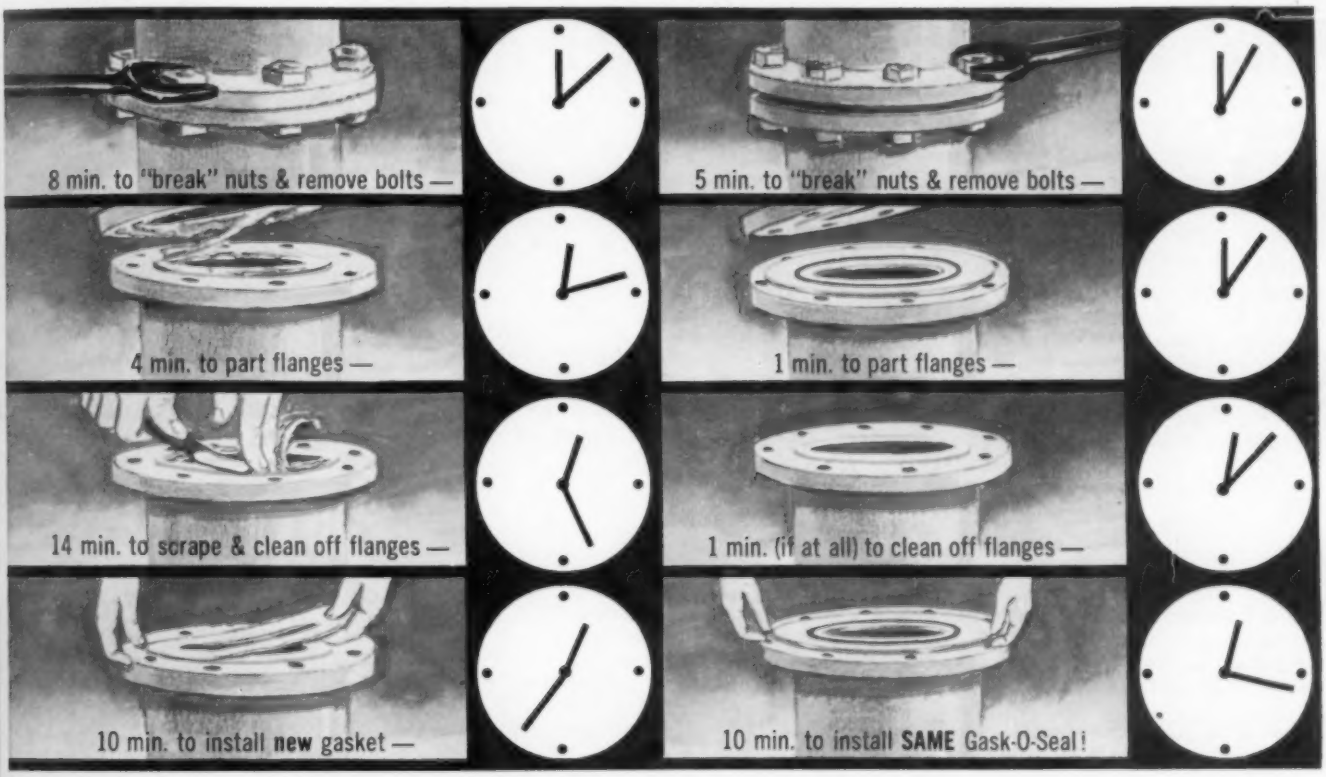
SIZES AND WEIGHTS AVAILABLE

O.D.	Wall	Wt. Per Ft.
4½	.125″	5.84
	.142″	6.61
	.156″	7.25
	.188″	8.64
	.219″	10.00
	.237″	10.79
6⅝	.156″	10.78
	.188″	12.89
	.219″	14.97
	.250″	17.02
	.280″	18.97

Acme-Newport Steel COMPANY
NEWPORT, KENTUCKY
A SUBSIDIARY OF ACME STEEL COMPANY

HOW TO SAVE *19 MINUTES* EVERY TIME YOU REPLACE A GASKET!

WITH ORDINARY GASKET | **WITH GASK-O-SEAL**


8 min. to "break" nuts & remove bolts —
4 min. to part flanges —
14 min. to scrape & clean off flanges —
10 min. to install new gasket —
5 min. to "break" nuts & remove bolts —
1 min. to part flanges —
1 min. (if at all) to clean off flanges —
10 min. to install SAME Gask-O-Seal!

TOTAL TIME 36 MINUTES | **TOTAL TIME 17 MINUTES**

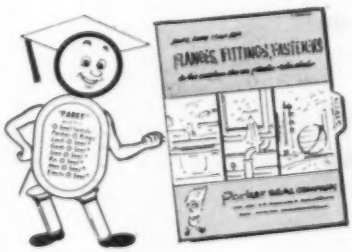
Fourteen major industrial plants report that it takes an **average** of 36 minutes to replace an ordinary gasket in standard ASA flanges . . . **with Gask-O-Seals it takes less than 17 minutes!**

There is no scraping or time consuming cleaning of flange faces necessary when you use Gask-O-Seals; no damaged flanges to be re-surfaced or replaced. And, Gask-O-Seal offers many other cost reducing features:

- They will not "blow-out".
- No retorquing of bolts is necessary.
- Vibration or pulse does not effect seal.
- They provide an opportunity to up-grade flanges — to reduce weight, bulk, bolt sizes and numbers . . . plus many more features.

Why not find out how Gask-O-Seals can save **you** time and effort. We'll be glad to send you complete information.

Write for Catalog 5422



Parker SEAL COMPANY
Culver City, California and Cleveland, Ohio
A DIVISION OF PARKER-HANNIFIN CORPORATION

For more data on advertised products, use cards, last page.

The newest reason to make your next tandem a FORD:

'61 FORD HEAVY DUTIES

GIVE TWICE THE CAB, FENDER AND RADIATOR LIFE!

Rugged Ford Heavy Duties utilize heavier gauge steel, sturdier reinforcements, and a new independent mounting system to separate cab, fenders and radiator. This stronger construction, with each component *individually* frame-supported, doubles cab, fender and radiator life—cuts downtime delays and maintenance expense.

CAB—A 25% heavier floor pan and toeboard provide a solid base for greater cab durability. New full-length door pillar reinforcements and stronger inner door panels minimize door sag. New triangular mounts keep cab level and protect it from frame-movement stresses.

FENDERS—Ford fenders are 25% heavier gauge, too. They are bolted to a rubber-cushioned transverse support in front for needed flexibility. Fender-wide rear brackets provide necessary rigidity. The removal of only 9 bolts permits pulling the fender assembly for easier access to engine.

RADIATOR—New Ford "lock-seam" construction doubles the solder area on key seams, and heavier gauge tank and header walls provide increased radiator strength. "Horse collar" mounting on rubber pads soaks up vibrations and diagonal braces at sides give solid support.

Ford's separate mounting of cab, fenders and radiator frees them from frame-movement stresses that occur when these parts are rigidly attached to each other. Result: failures and service costs are reduced even in tough off-road operation.

Ford T-Series tandem rear axle trucks and tractors are available with GVW's up to 51,000 lb.—GCW's up to 75,000 lb. Your choice of Timken or Eaton axles with up to 38,000 lb. tandem capacity. Seven exclusive-truck V-8 engines range from 302 to 534 cubic inch displacement.

SEVEN MORE REASONS WHY IT'S GOOD BUSINESS TO DO BUSINESS WITH FORD!

You save from the start with Ford's traditionally low prices, and your savings continue with low operating and maintenance costs. These facts are documented by certified test reports from America's foremost independent automotive research firm. Ask to see these reports. They're on file at your Ford Dealer's.

In addition to these dollar-and-cents savings, the following bonus benefits are yours with Ford Trucks:

1. **Rigid quality controls** give you the strongest safeguard of truck reliability ever. Modern, *exclusive-truck* manufacturing facilities, with emphasis on quality every step of the way, are designed to give you a Ford Truck that is as free from defects as a truck can be. Tangible results of these high standards are Ford's new warranties.

2. **Exclusive 100,000-mile warranty** (or 24 months) on 401-, 477- and 534-cu. in. Super Duty V-8's is the most liberal in the industry. Each major engine part (including block, heads, crankshaft, valves, pistons, rings), when engine is used in normal service, is warranted by your dealer against defects in material or workmanship for 100,000 miles or 24 months, whichever comes first. The warranty covers full cost of replacement parts . . . full labor costs for first year or 50,000 miles, sliding percentage scale thereafter.

3. **12,000-mile warranty** (or 12 months) on all 1961 Ford Trucks of every size is further evidence of the confidence Ford has in its quality controls. Each part, except tires and tubes, is now warranted by your dealer against defects in material or workmanship for 12 months or 12,000 miles, whichever comes first. The warranty does not apply, of course, to normal maintenance service or to the replacement in normal maintenance of parts such as filters, spark plugs and ignition points.

4. **Special fleet financing** can be arranged by your Ford Dealer. It's available for owners of two or more trucks, and provides the opportunity to precisely tailor payments to your income patterns or depreciation schedules. This fleet-fitted financing offers substantial savings and frees your working capital.

5. **Sales engineers and service specialists** in 36 district offices are on call to solve special truck problems. Working with both dealers and customers, these experienced truck men represent another extra step Ford takes to provide your continued satisfaction.

6. **Replacement parts depots** at 26 strategic locations across the country quickly supply needed parts from ample stocks. Ford's entire supply system is geared to give you faster service and reduce costly downtime . . . *wherever* you are.

7. **6,800 Ford Dealers,** including 280 specialized Heavy Duty truck dealers, can keep your trucks ready to go wherever they go. From coast to coast, fast Ford service—gas *and* Diesel—is always close at hand.

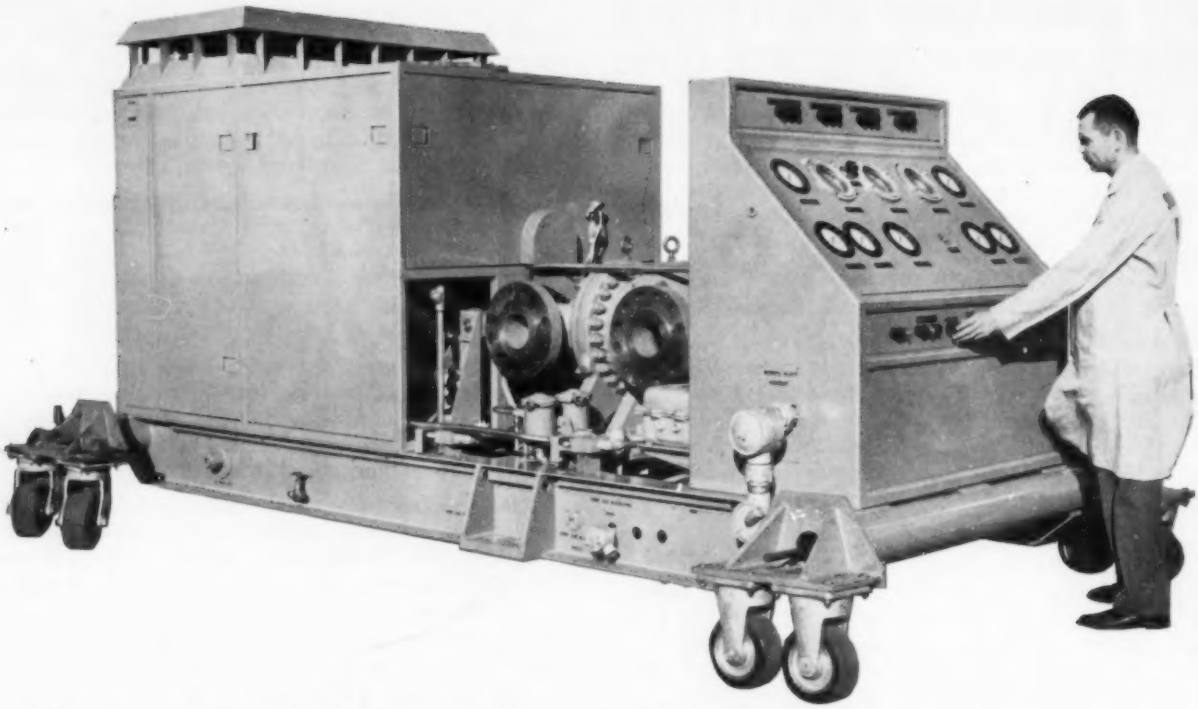
From Super Economy pickups to Diesel-powered tractors, you can now fill every truck need up to 76,800 pounds GCW with a modern, money-saving Ford Truck.

Quality-Built...Maintenance-Engineered

FORD TRUCKS COST LESS

FORD DIVISION, Ford Motor Company

For more data on advertised products, use cards, last page.



Compact Solar gas turbine compressors cost less to buy, run and maintain

Solar centrifugal gas turbine compressors are so light and compact they can be mounted on the back of a truck, skids or extremely lightweight foundations. Their simplified design and construction mean they cost less to buy, install, operate and maintain. Their versatility makes them ideal for both field boosting and main pipeline applications.

Solar compressors are now in operation powered by Solar's *Saturn* 1100 hp industrial gas turbine. The *Saturn* engine weighs just 1200 lbs and measures 77 inches in length by 44 inches in width by 44 inches in height. It is virtually vibrationless, starts instantly and requires no warmup—making it ideal for remote or unattended operation.

Solar compressors represent a fundamental advance in the field, made possible by high performance, long-life Solar turbines. Driving the compressor directly at turbine rotating speeds results in a small, high efficiency package for the range of 5 to 150 MM SCFD or 75 to 1500 cfm.

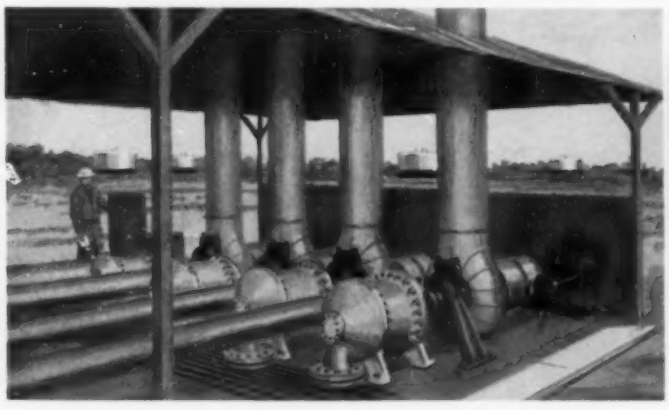
A new concept of multi-staging and interchangeable compressor wheels allows low cost field changes to accommodate new flow and pressure requirements. Maintenance is unusually simple and is facilitated by the compressor's easy portability.

Detailed information on Solar's new gas turbine compressors is available by writing to Dept. J-118, Solar Aircraft Company, San Diego 12, California.

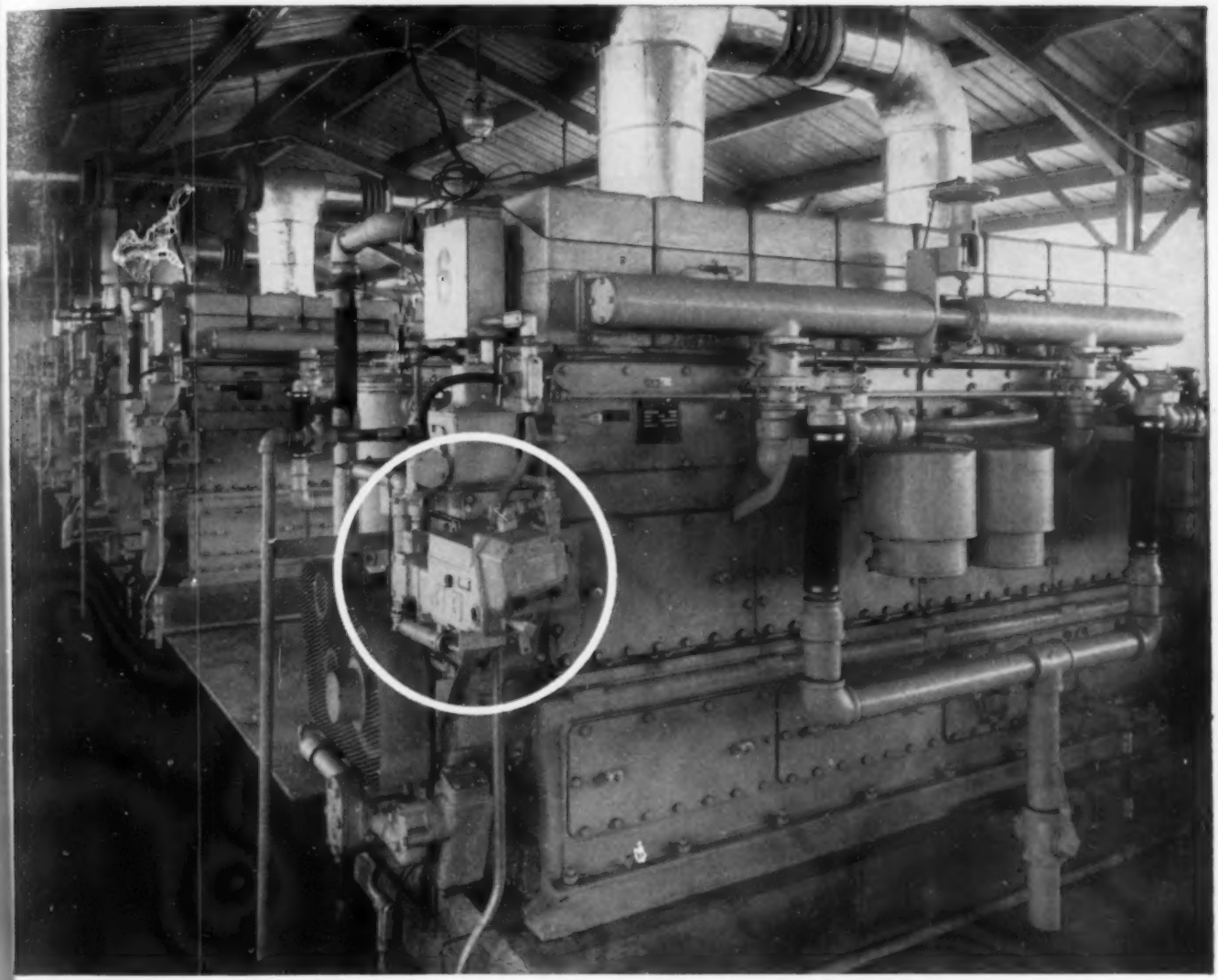
SOLAR

A subsidiary of International Harvester Company

Multiple unit installations facilitate maintenance.



Easy transportation for installation or maintenance.



Circle indicates Bendix LC magneto on White Superior engine at Long Beach.

BENDIX LC MAGNETOS HELP POWER GIANT LONG BEACH WATER-FLOODING PLANT

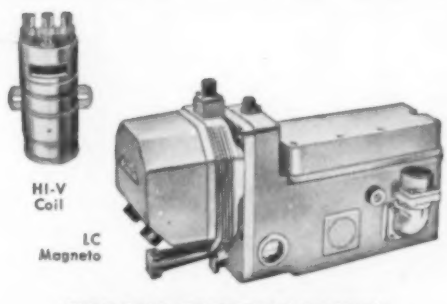
Long Beach, California, operates what may become the world's largest water-flooding plant—drawing water from the Pacific Ocean and pumping it into the Wilmington Tract beneath the city. The additional pressure created will aid in oil recovery and, it is hoped, will reduce land subsidence in the area.

Currently operating at a rate of 120,000 barrels per day, the capacity will be increased and may eventually reach 1,000,000 barrels per day—which would make it the world's largest project of its kind.

The plant is powered by eight White Superior gas engines equipped with Bendix* LC magnetos and HI-V transformer coils. These matched ignition systems, noted for long service life, simplified maintenance at low cost and complete operating reliability, can be used with engines of from six to sixteen cylinders.

If you want to know why major operators are specifying Bendix LC Ignition, write SCINTILLA DIVISION, THE BENDIX CORPORATION, SIDNEY, NEW YORK.

*REG. U.S. PAT. OFF.



MATCHED IGNITION SYSTEM

Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y. *Canadian Affiliate:* Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec. *Factory Branch Offices:* Burbank, Cal.; Orlando, Fla.; Chicago, Ill.; Teaneck, N. J.; Dallas, Tex.; Seattle, Washington; Washington, D. C.

Scintilla Division
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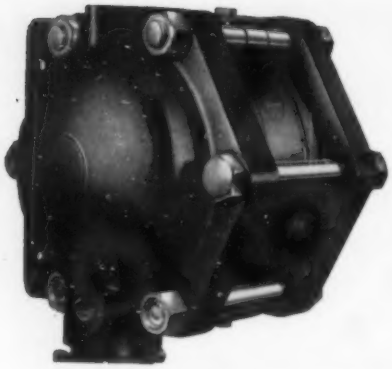
THE Bendix CORPORATION



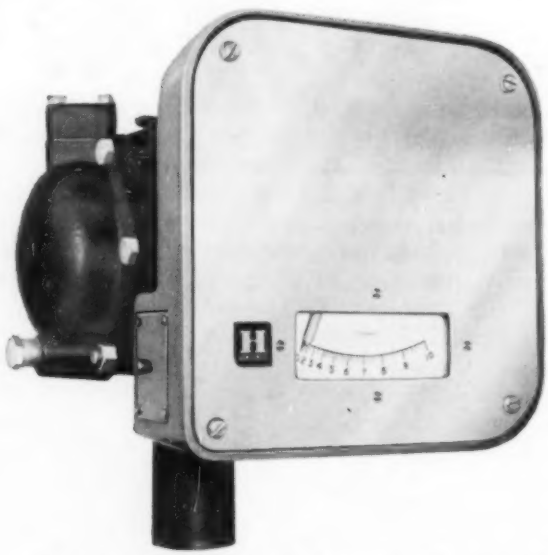
Honeywell Bellows Meter brings

Six of many ways you can use the bellows meter

As a Recorder or Integrator—Recorders can have one, two or three pens, with the second and third pens actuated by thermometer or pressure elements. A single-pen recorder is shown above. You can get integration, too.
Write for Specification S 292-2a.

As Recording Controllers—You can get recorders with pneumatic ON-OFF, 10% *Throttlor*, 150% *Throttlor* with manual reset, or *Air-O-Line* (150% proportional band-plus-automatic reset) control. A single-pen pneumatic controller with integral bypass is shown above.
Write for Specification S 292-2a.

As a Non-indicating Pneumatic Transmitter—Use this non-indicating transmitter when you don't need indication at the point of measurement, and when the measured variable is to be transmitted to remotely located instruments.
Write for Specification S 230-1.



As an Electric Transmitter—You can use this *ElectriK Tel-O-Set* electric flow and liquid level transmitter with indicators, recorders, and controllers, with data handling systems, or with millivolt receivers. Field indication, as shown, is optionally available.
Write for Specification FS 301-7.

new versatility to flow or liquid level measurement

As an Indicating Pneumatic Transmitter—Gives you indication at the point of measurement, plus pneumatic transmission. Easy-to-read scale, and large indicating pointer. Case is only 4 by 7 by 9 inches.
Write for Specification S 230-1.

As a Dial Indicator—Six-inch dial indicator gives easy, accurate readings at point of measurement. This meter-indicator is designed specifically for field indication.
Write for Specification S 224-1.

You can use the Honeywell Bellows Flow Meter as a recorder, controller, indicator or transmitter . . . pneumatic or electric. Use it for accurate, low-maintenance metering of flow—for steam, water, gas, oil or other fluids—or for liquid level measurement. In all of its many forms, with all of its performance advantages and operating economy, it is the most advanced flow and liquid level meter available today.

Some outstanding features:

Stability—The meter body will operate over an ambient temperature range of —40° to 250°F. Over a range from —32° to 150°F. the accuracy will not change more than 0.5%.

Leakproof construction—Hydraulically formed stainless steel bellows eliminate any chance of leakage between fill and process fluid.

Quick, easy damping—Rectangular orifice pulsation check varies the speed of response over a ratio of 20 to 1. Adjustment is essentially linear and can be made from outside the meter body while the instrument is operating.

Sensitivity and accuracy are well within the required limits of measurement and control on applications for which these instruments were designed.

Convenience—Change range easily in the field by replacing a single range spring assembly. The meter body is self-venting when measuring liquids and installed below the flow line; self-draining when measuring gas and installed above the flow line.

There are models of the Honeywell Bellows Flow Meter available in many ranges, for every application. Your nearby Honeywell field engineer can give you complete details and help you select the correct model for your application. Call him today.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

Honeywell

First in Control

SINCE 1885

HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

SAVING TIME ... SAVES MONEY — SAVE BOTH WITH ..

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LAFAYETTE, LA. — P. O. BOX T

PETROLEUM HELICOPTERS

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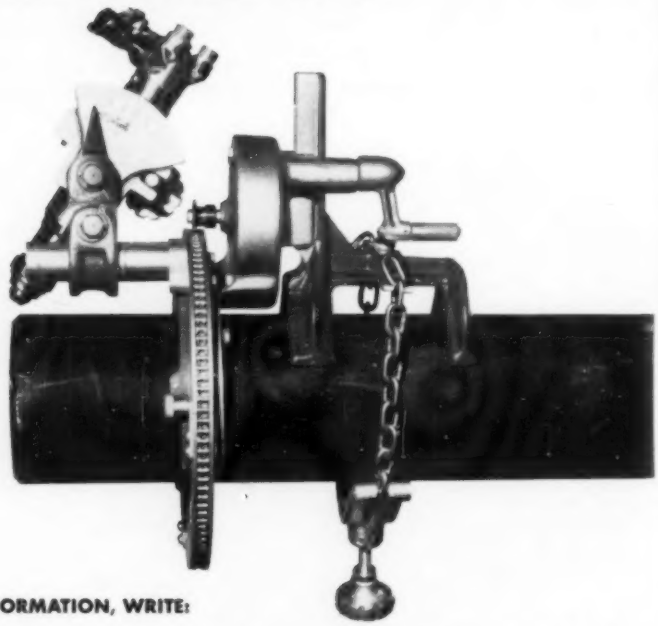
NEW! COMPACT!

CROSE-PERRAULT MODEL "O" BEVELING MACHINE

New smaller size model "O" compact beveling machine will cut and bevel coated pipe with much less cutback. Handles small diameter pipe from 1½" to 4". A full circle traveling ring cuts and bevels pipe simultaneously to assure accuracy. This ring eliminates jerky movement and insures a cut so smooth that buffing costs are negligible. Easy to install on closed section of pipe. Light weight, rigid, constructed of finest aluminum alloy.



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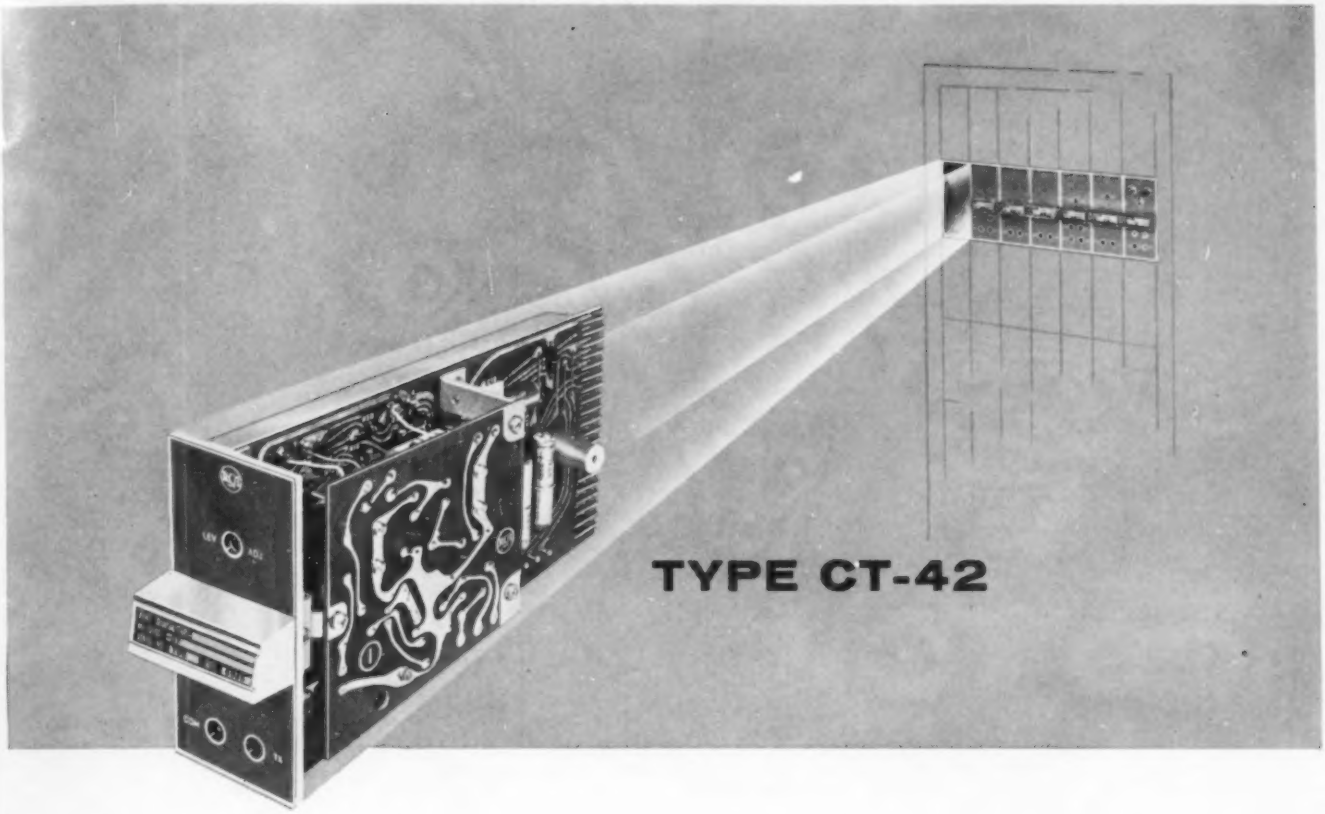

SOLID STATE TONE MULTIPLEX

FOR WIRELINE, MICROWAVE OR CARRIER

24 channels from 420 to 3180 cps—Spaced every 120 cycles (CCITT Standards)
18 channels from 4300 to 7600 cps—Spaced 170 to 220 cycles

The CT-42 is an all new tone multiplex of high performance designed to operate over a wide environmental range. Ruggedly built, it uses computer grade components for lasting dependability.

Each channel can be frequency-shift or AM keyed for teletype, telemetering, control or data signals. Six transmitters or receivers in any combination may be plugged into a standard shelf which also contains a husky regulated power supply.

Channel units operate from 24 V DC or 117 V AC power supply.

If you are looking for the newest and best in tone multiplex equipment, mail the convenient coupon for complete specifications and prices.

The Most Trusted Name in Electronics
RADIO CORPORATION OF AMERICA

RADIO CORPORATION OF AMERICA
Microwave Equipment, Dept. X-418
Building 15-5, Camden 2, N.J.

☐ Please send new catalog sheet and price list on Type CT-42 Tone Equipment.

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COMPANY_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

For more data on advertised products, use cards, last page.

W-K-M DIVISION

ACF INDUSTRIES

65

41

13

89

98

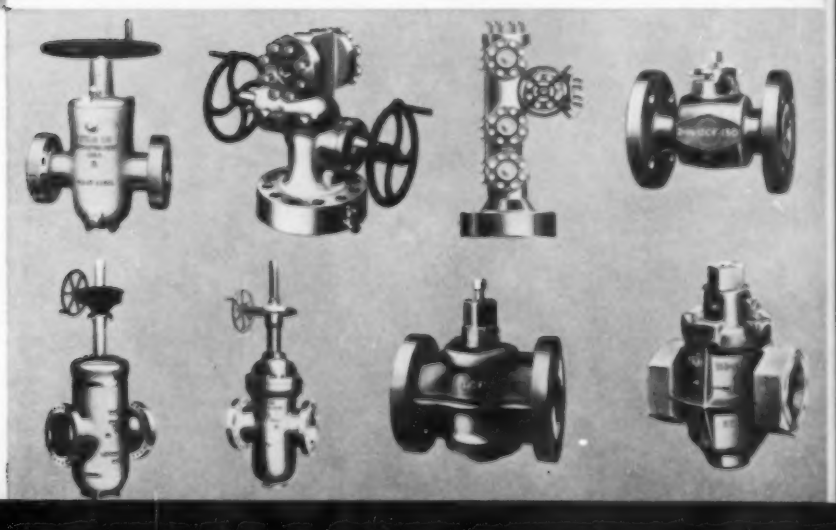
4

THE "SIGNATURES" OF MASTER CRAFTSMEN ARE ON EVERY W-K-M VALVE

As your guarantee of the superior skill and workmanship that go into every W-K-M valve, each master craftsman stamps his personal emblem in the metal when he completes a part. The uniformly high quality of W-K-M workmanship is equalled by advanced engineering and methods of manufacture. Performance is the final measure of the value of a valve . . . when you install W-K-M you may be confident of satisfaction and long economical service.

When So Much Depends on a Valve

. . . *Specify* W-K-M

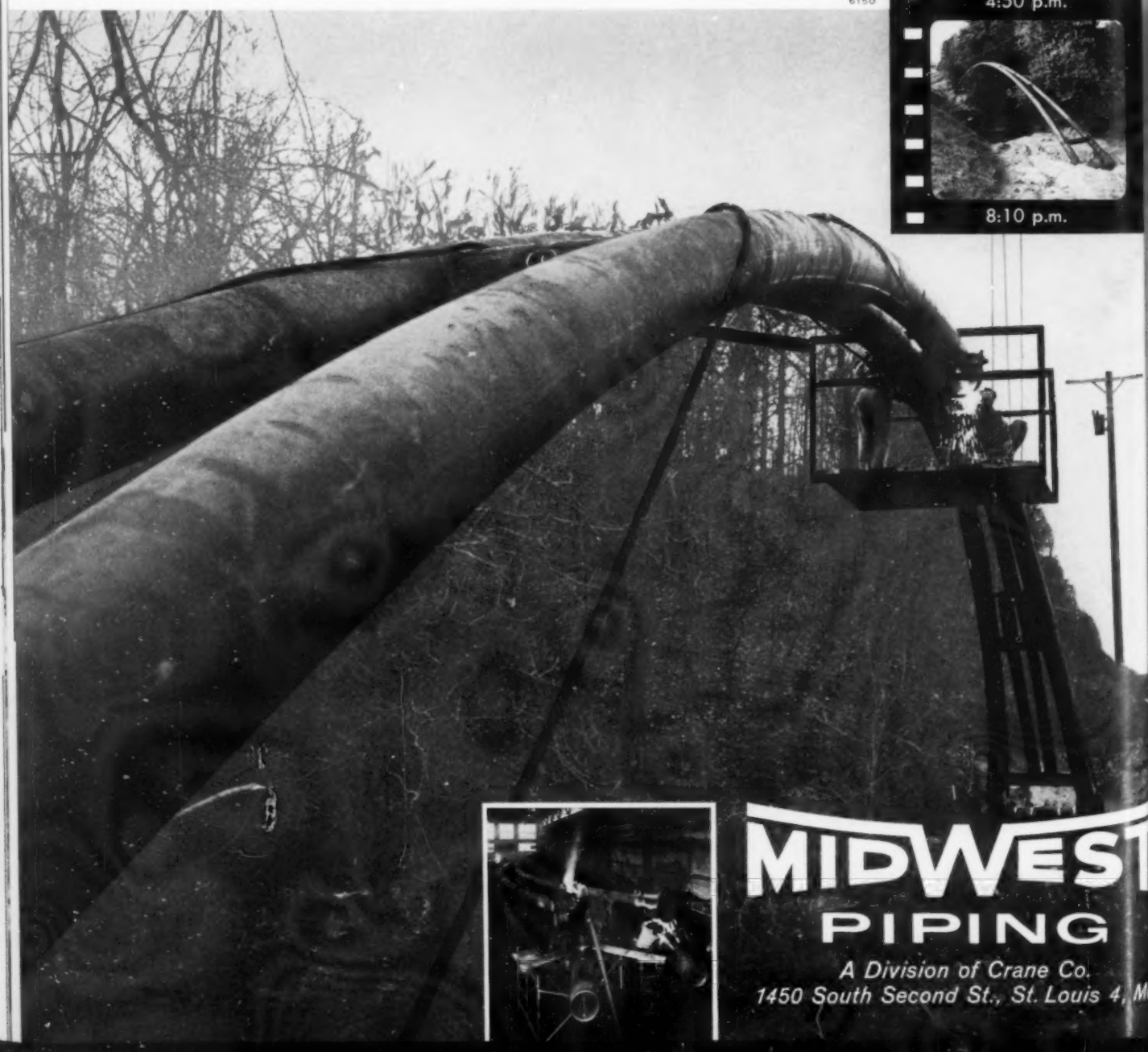


Spans creek in one day with pre-fabricated pipe arch

THIS self-supporting river crossing for a 20-inch gas pipeline was installed by Laclede Gas Co. in just one 12-hour working day. Midwest Piping pre-fabricated the entire 150-foot arch and its base headers in only two sections, each consisting of a converging pair of 16″ pipes.

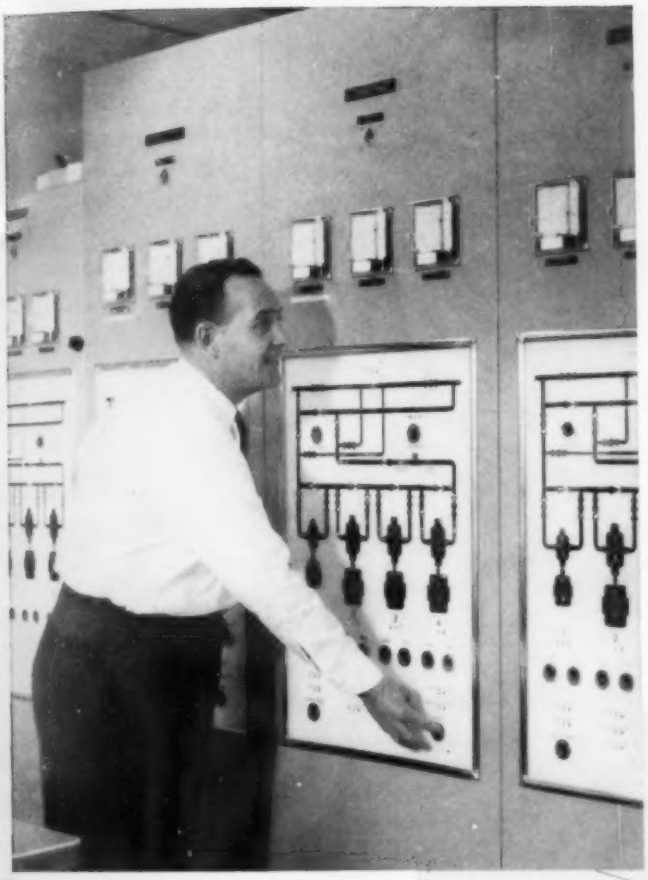
The only installation of its type in the country, the arch is capable of carrying 200 million cubic feet of gas daily at 880 psi over the solid rock bed of Coldwater Creek north of St. Louis. For complete information on Midwest Piping's products and services, write for Bulletin 61A, PIPELINE FITTINGS.

6150

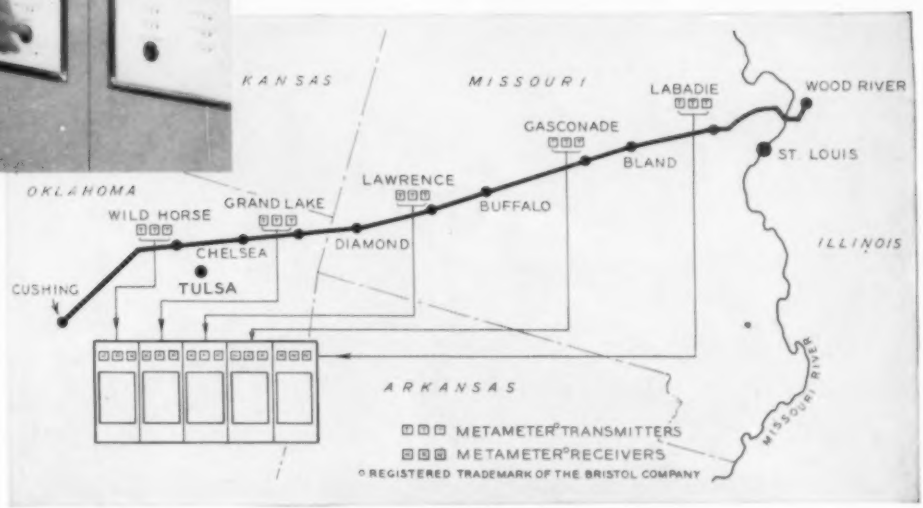


MIDWEST
PIPING
A Division of Crane Co.
1450 South Second St., St. Louis 4, M

Bristol telemetering "mans" half the stations on 400-mile crude oil pipeline



Miniature Bristol Metameter® Telemeter Recorders (top row) on central supervisory control panel at Cushing office of Shell Pipe Line Corporation. Instruments, occupying only 5"x5¼" on panel, indicate and make permanent record of suction, case, and discharge pressure at each of five unmanned stations along 400-mile pipe line. (See map.)



Bristol Metameter* system permits efficient, instantaneous supervision from central office, frees valuable personnel from routine duties.

Midcontinent Division of Shell Pipe Line Corporation, Houston, Texas, uses a Bristol Metameter System for telemetering on the Ozark Pipe Line System, a 400-mile pipe line from Cushing, Oklahoma, to Wood River, Illinois. This system is jointly owned by Shell Pipe Line Corporation and The Texas Pipe Line Company and is operated by Shell Pipe Line.

The Bristol Metameter telemetering system brings pressure readings from five unmanned pumping stations (out of 10 stations in all) along the pipe line into the central dispatching office in Cushing, Oklahoma. (See map.) Using the telemetered readings, the Cushing office can exercise complete supervisory control over pump operation at the unattended stations. Every other station along the line is manned, including the junction point, Cushing, and the terminus at Wood River. This puts personnel within a reasonable distance to take corrective action if trouble develops.

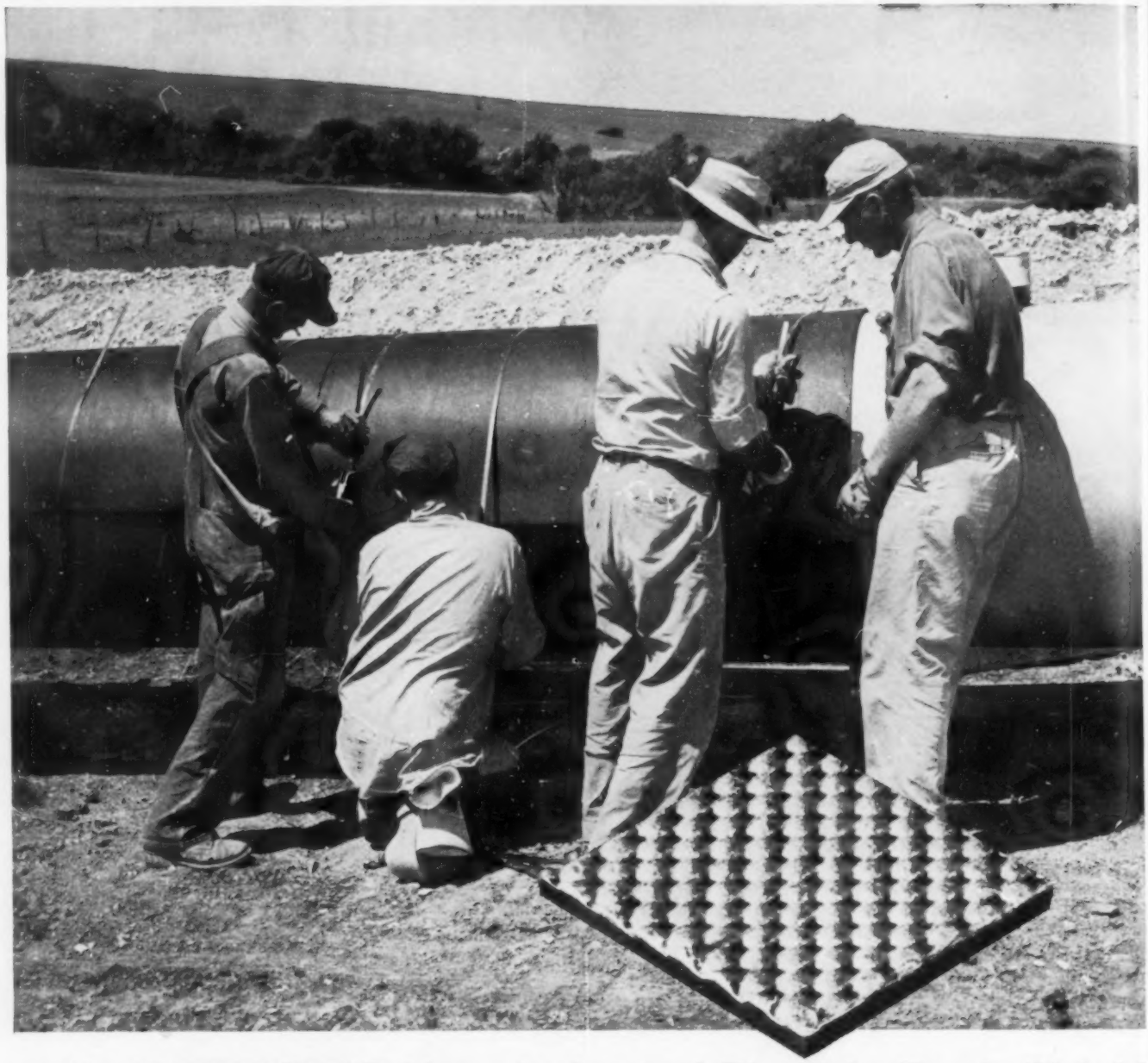
Whether they're used on oil pipe lines, natural gas pipe lines or distribution systems, electric power systems, water plants, or in steel mills or other industrial plants, Bristol telemeters can practically always improve operating efficiency and cut costs. Their accurate, precise readings are transmitted with the speed of radio (VHF, UHF, microwave), or telephone or carrier current lines for distances that may vary from a few yards to hundreds of miles. Pressure, liquid level, flow (including total corrected flow), temperature, mechanical motion, voltage, current, and power are just a few of the variables that can be transmitted.

Bristol developments in industrial telemetering, soundly based on more than 45 years' experience in this field, are making possible today a speed and an effectiveness in central supervisory control that would have been undreamed of only a few years ago. Let us give you full details. Write: The Bristol Company, 114 Bristol Road, Waterbury 20, Conn.

**T. M. Reg. U. S. Pat. Off.* O-19

For more data on advertised products, use cards, last page.

WRAP UP THE JOB



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Lighter Weight! Lower Freight Costs! Extra Cushioning!

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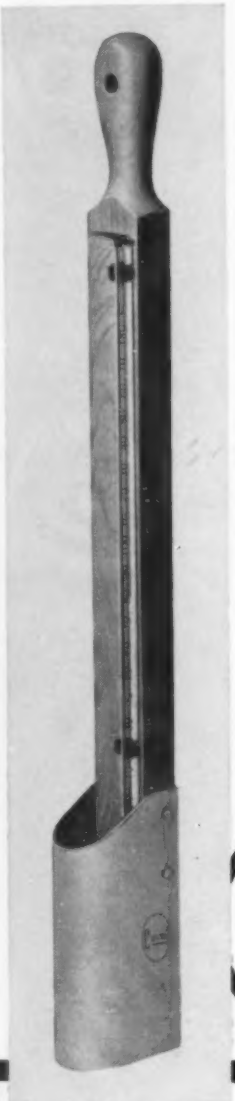

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The Curtin Valve Type Tank Thermometer incorporates a bucket valve which opens as the thermometer is lowered into the tank, allowing oil to flush through the cup to keep the mercury column at or near exact temperature of oil. When the thermometer is withdrawn, the bucket valve closes, retaining a sample from the desired level.

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* Patent Applied For

Curtin Valve Type Wood Case Tank Thermometers		
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16764A4	0 to 180	6.50
†16764A6	20 to 260	6.90
16764A8	170 to 500	7.50

†Conforms to ASTM specification except for range.

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WHY 754,900 FEET OF SPANG PIPE WERE USED FOR NEW SEADRIFT PIPELINE

Seadrift Pipeline Corporation, a subsidiary of Union Carbide Corporation, used three quarters of a million feet of SPANG seamless line pipe in their new 108-mile dual pipeline from Seadrift, Texas, to the Humble Oil Company gas plant near Ella, Texas.

There are many reasons why oilmen feel safe when they specify SPANG pipe. They know that SPANG has taken every precaution to assure strength, ductility and uniformity of the pipe. SPANG pipe has been serving industry needs successfully since 1840. It is produced by National Supply, the world's largest supplier of oil country equipment and products.

These are a few of the reasons why SPANG pipe is preferred by oilmen. The next pages cover additional reasons.

NATIONAL NSCO SUPPLY

PIPELINERS FIND SPANG SEAMLESS PIPE IS

754,900 feet of SPANG seamless line pipe were used by the Seadrift Pipeline Corporation, a subsidiary of Union Carbide Corporation, in this new pipeline from Seadrift, Texas, to Ella, Texas. Order was made up of 3½", 4½", and 6⅝" O.D. pipe.

DUCTILE, EASY TO WELD, UNIFORMLY ROUND

Stringent quality control in every phase of production and shipment. This is probably the most important reason for the superiority of SPANG pipe in gathering, distribution and transmission lines.

Quality control is a specialized business in National Supply's modern Ambridge mill, where SPANG pipe is made. This control starts with the chemical and physical properties of the steel and is carried through every step of production and inspection.

The finished pipe is subjected to thorough testing through internal and external surface inspections, hydrostatic tests and dimensional controls, such as O.D., wall thickness, end bevel and straightness checks.

At the end of production and inspection cycles, and before SPANG is stenciled on the pipe, we are sure it meets the appropriate API specification.

Uniformity of SPANG pipe is an important benefit. The uniform roundness speeds welding. And pipeline crews like the SPANG ductility for operations over rough terrains.

SPANG seamless line pipe for gathering, transmission and distribution lines is readily available in sizes from 2 inches (nom.) through 14 inches O.D., and in specifications API STD. 5L and API STD. 5LX.

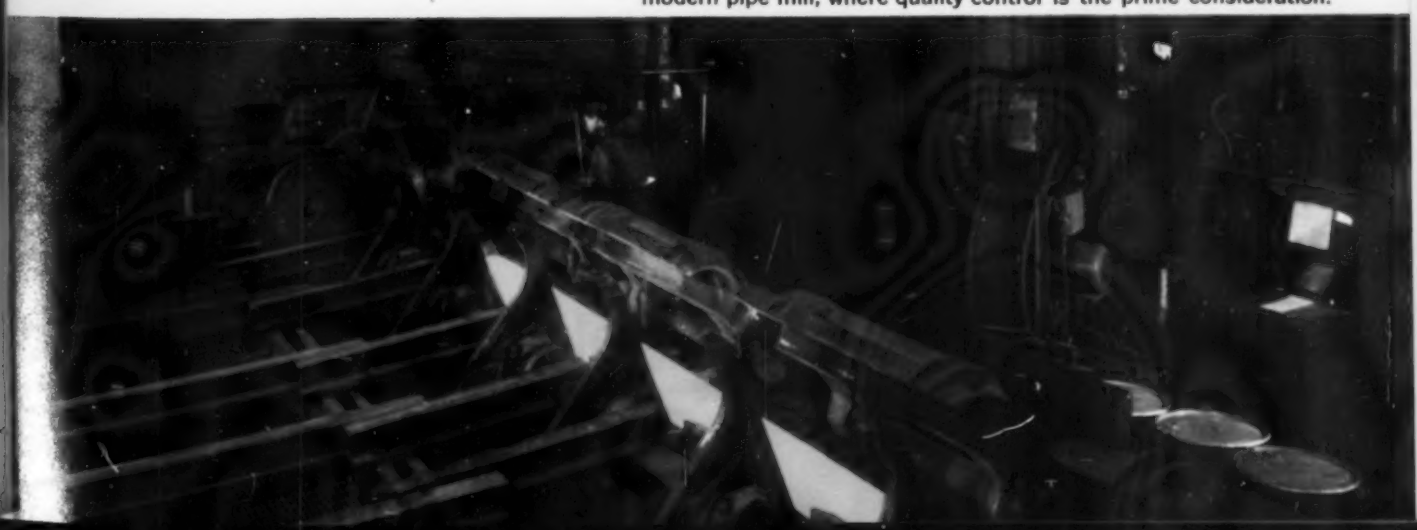
Next time you buy pipe, play it safe. Order SPANG seamless pipe from your National Supply representative, or write to National Supply Division, Armco Steel Corporation, Two Gateway Center, Pittsburgh 22, Pa.

Stenciling the SPANG name is final step in production of high-quality pipe under standards that meet API specifications.

Steel's Symbol of strength, long life, and economy

Steel

SPANG pipe is produced by National Supply at Ambridge, Pa., in a modern pipe mill, where quality control is the prime consideration.



SPANG PIPE SPEEDS INSTALLATION OF GATHERING AND FEEDING LINES

National Supply also produces SPANG CW butt-weld pipe under stringent controls. Every length is hydrostatically tested and inspected for thread quality and uniformity.

All SPANG pipe is made of carefully selected steel that meets the toughest standards. This control assures you of pipe that is easy to work, because it is easy to cut, bend, thread and weld.

Call your nearby National Supply representative, or write to National Supply Division, Armco Steel Corporation, Two Gateway Center, Pittsburgh 22, Pennsylvania.

Gathering line service is one of many oil field applications for SPANG CW pipe. In addition to gas, oil and water lines, you can use it for many structural purposes.

ARMCO National Supply Division

PIPE LINE PANORAMA

New FPC Chairman Sept. 1 . . . Joseph Swidler, President Kennedy's chairman designate, and Howard V. Morgan were sworn in as commissioners June 28. After ceremony, Chairman Jerome Kuykendall announced he will continue as chairman for two months transition period and "will stay on as a member after Sept. 1 for a time."

TIPRO Up in Arms Over "Integration Trends" . . . First it was a resolution passed in May by the 6,000-member Texas Independent Producer and Royalty Owners Association: "If it is determined that actions by purchasers of crude oil or natural gas are in any manner tending toward restraint of competition or violation of appropriate statutes, the organization may present its findings to appropriate governmental agencies for such action as they determine advisable." Texas producers believe there's an accelerating trend toward self-sufficiency by crude oil purchasers and interstate natural gas pipe lines.

Then, late in June, TIPRO President James F. West lashed out—this time against proposed FPC rules changes handed down May 22. Suggested orders would establish a new standard of "pipe line quality" for natural gas, provide for price reductions below this quality, and outlaw certain "Take-or-pay" provisions in producer-pipe line contracts. Included with latter is new formula under which producers could not sell over 1,000 cubic feet of gas per day for each 8 million cubic feet of reserves in place.

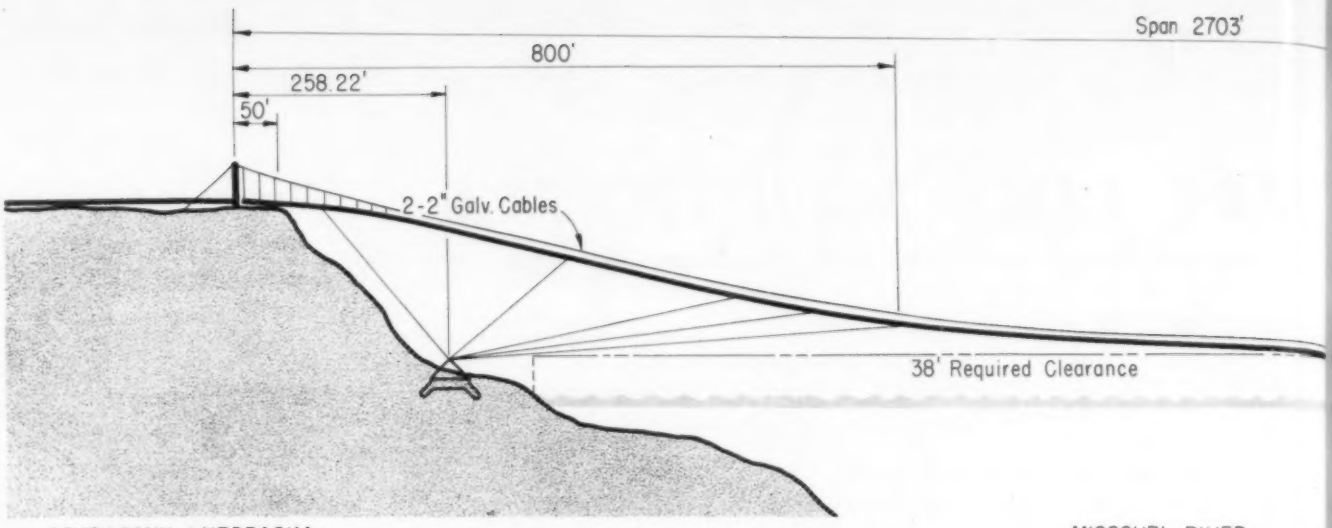
TIPRO President says "pipe line quality" standard "would advance threatened monopoly of natural gas industry by providing bigger boon to pipe lines at direct expense of consumers and producers." And added: "If the Commission deliberately set out to prevent future sales of natural gas in Interstate Commerce, it could not devise better rules to do so than the ones suggested."

Now an Eastern Railroad To Enter Pipe Line Industry . . . Pennsylvania Railroad is entering products pipe line business. Proposal is to use railroad's right-of-way for a pipe line that would supply aviation gasoline to Baltimore's Friendship Airport. Also to Washington's National Airport, Andrews Air Force Base, and Dulles International Airport. Pennsy will be first Eastern road to own a pipe line.

How to Lay Two Miles of 8-Inch Line in 2,500 Feet of Water—and recover it—in 24 hours . . . French pipeliners have developed new technique for deep water pipelining. Method works so well that Gaz de France crews have been laying lines in 2,500 feet of Mediterranean waters just for practice. They tow two miles of 8-inch pipe 15 miles out from North African coast, lay it in half-mile deep water, recover it, and return it to its moorings—all in one day's time.

Technique hinges around a new type buoy the French have developed. And next month's PIPE LINE INDUSTRY will describe the method and equipment in detail. France's Minister of Industry, M. Jeanneney says problems of deep water pipelining can be considered solved, and that gas line crossings of the Mediterranean to bring vast reserves of Algeria to market in West Europe await only action of diplomats. This could well be Free World's answer to Russia's stepped up effort to move into West Europe fuel markets.

Pipe Line Briefs . . . All-industry wave of price-cutting has spread to seamless line pipe; U.S. Steel announces price cuts at the mill of $15-$18 per ton on 6⅝-inch to 12¾-inch pipe, including API grades A, B, X-42, X-46, and X-52, in wall thicknesses .250-inch and lighter in double random lengths . . . Canada's Interprovincial Pipe Line says 100,000-barrel test shows large volume batches of gas liquids can be moved through its crude oil line; has filed tariff of 44 cents per barrel Edmonton to Chicago for 50,000 bpd, says it can extend line if business is offered . . . Deferred wage increases in construction industry have averaged 13.6 cents per hour under contracts signed prior to 1961; range was from 5 cents to 23 cents per hour, as compared with 10.6 cents average increase in pipe line common labor rates negotiated recently.



New Design Makes World's Longest Pipe Line Suspension Span Possible

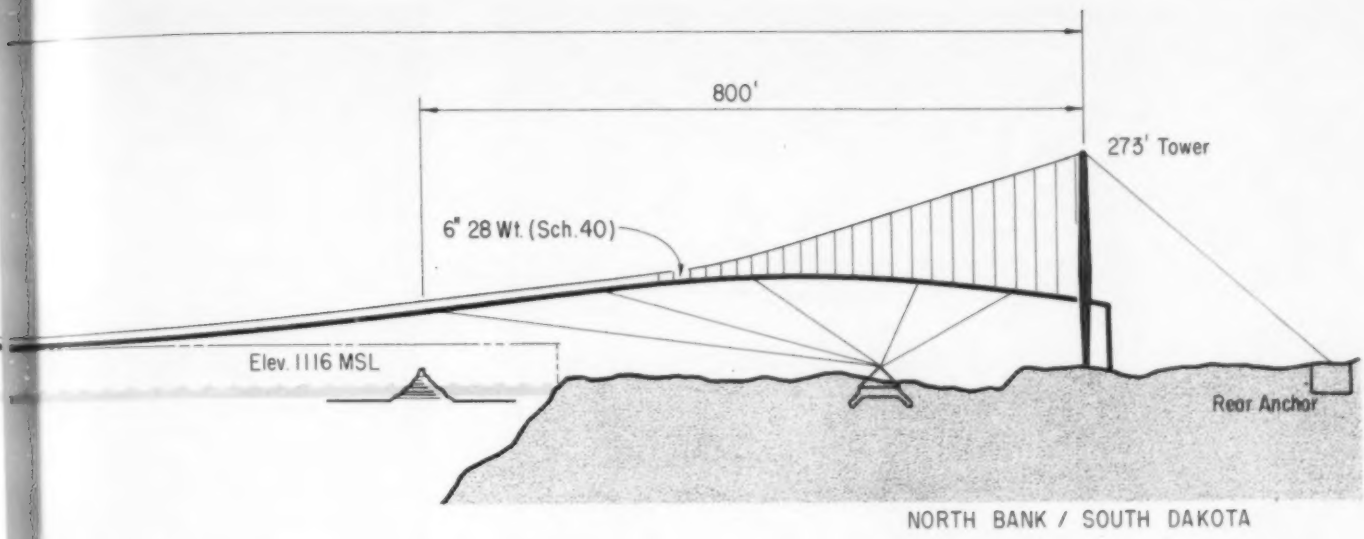
From tower-to-tower the Missouri crossing measures 2,703 feet, and one end is supported by a 273-foot tower believed to be the world's tallest structure ever to be erected in one piece. But the outstanding feature is the new design concept

By Donald M. Taylor
Engineering Editor
PIPE LINE INDUSTRY

SOON AFTER they raised the tower that supports the world's longest aerial pipe line span near Elk Point, S.D., farmers converged on the site from 20 miles around. Many thought the tower which stands almost as high as a 30-story building was a gigantic missile that had been raised to firing position.

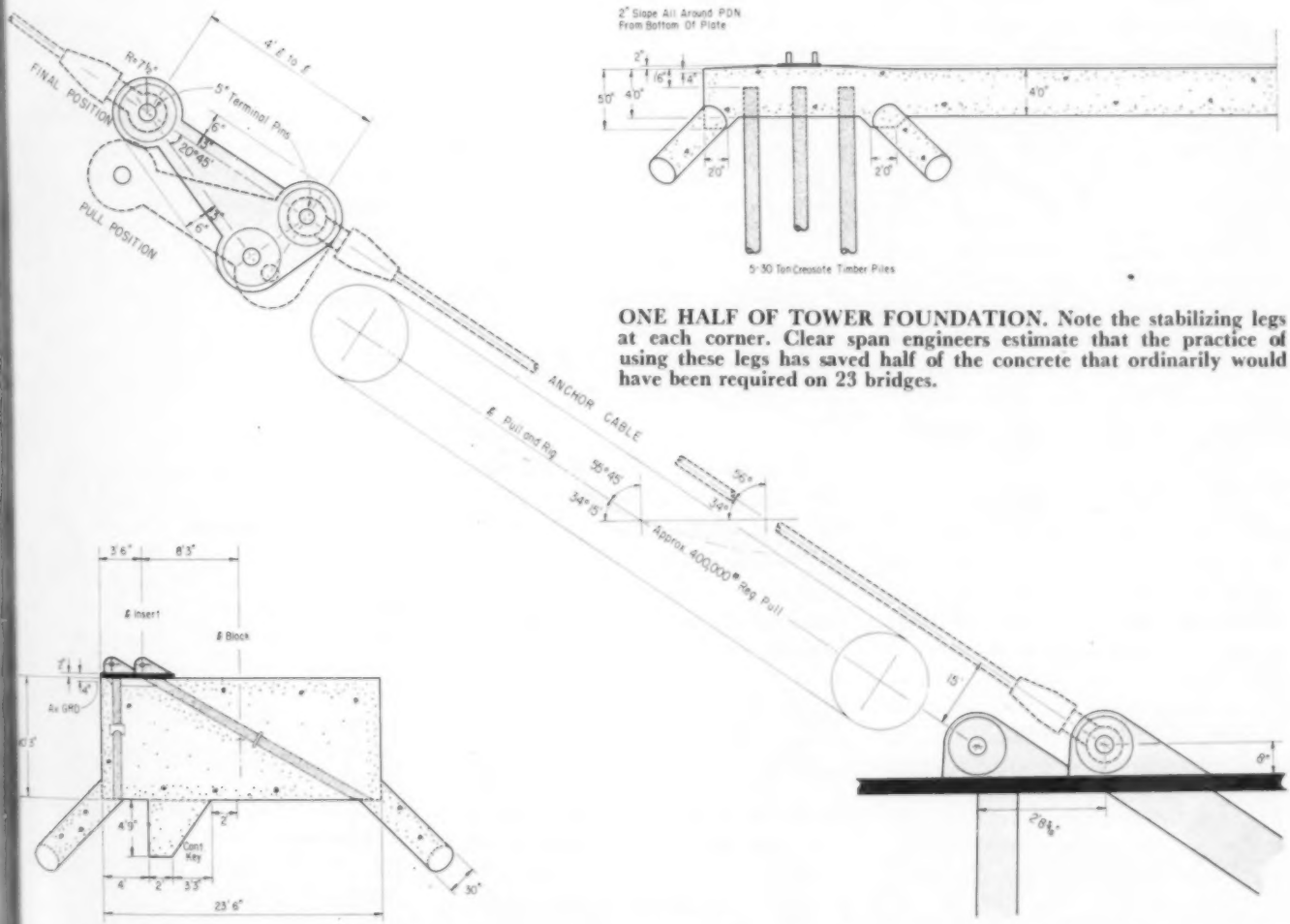
"Don't think you'll ever get 'er off the ground," muttered one of the farmers gesturing toward the 273-foot orange and white tower that loomed in the sky a quarter of a mile away. "It's just too doggone big!"

CROSSING PRIOR TO ERECTIO
Note the gin pole and supine tower on t distant north bank.



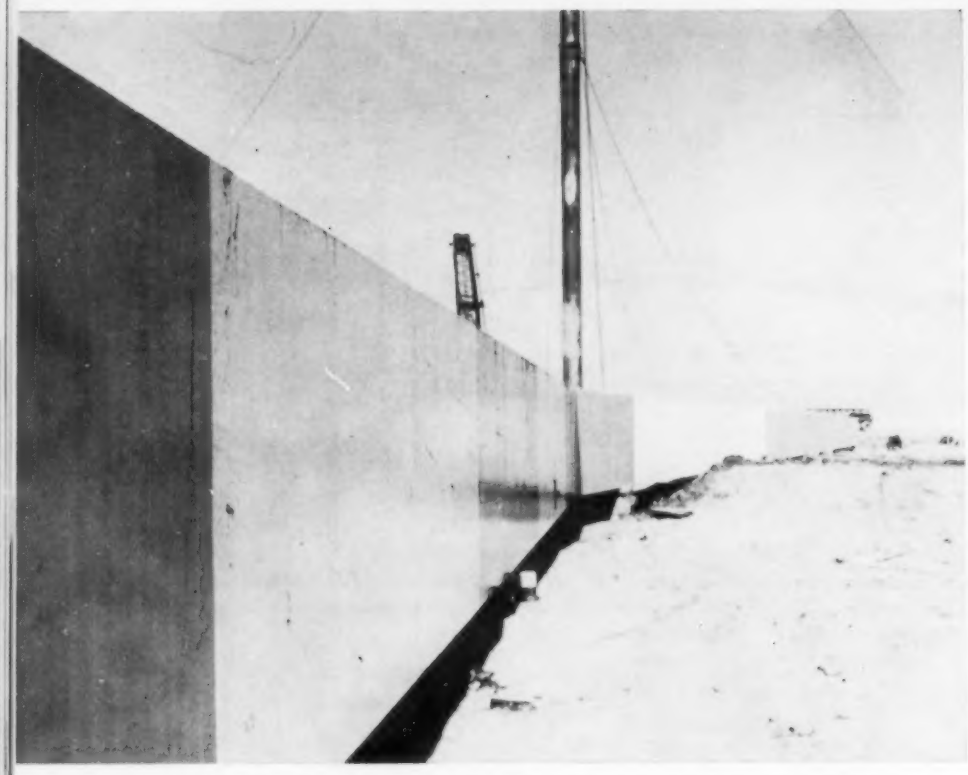
THE WORLD'S LONGEST PIPE LINE BRIDGE. Airline distance from tower is 2,703 feet. Distance by pipe line is 2,730 feet. The tower at the right is perhaps the tallest structure of any kind ever to be erected in one piece. Unusual design feature is that the pipe and the supporting main strands hang parallel in tension for most of the distance.

ONE HALF OF TOWER FOUNDATION. Note the stabilizing legs at each corner. Clear span engineers estimate that the practice of using these legs has saved half of the concrete that ordinarily would have been required on 23 bridges.

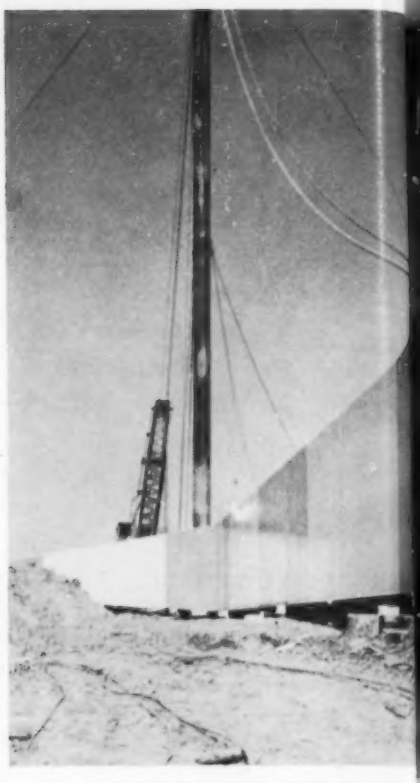


REAR ANCHOR FOUNDATION is designed to resist forward and upward pull. Note the key in the bottom.

THE ERECTION LINK. Tower is pulled erect from the bottom hole. After tower goes past top dead center, the anchor cable insert at top is pinned to the link as shown, and it assumes position shown here.



GIGANTIC 273 FOOT TOWER lies on north bank of the Missouri awaiting erection. The 36-inch gin pole is in the background.



READY FOR ERECTION. Note that the main strands fastened to the top of the tower pass over

While the farmer was wrong in his assumption that he was attending a missile launching, his trip as a curiosity-seeker could be considered a whopping success. For there were many noteworthy events in evidence that day. The huge tower, for instance, is believed to be the tallest structure of any kind ever to be raised in one piece; and the pipe line span attached to it is the world's longest suspension aerial crossing—measuring 2,703 feet from tower-to-tower.

But even more important, the new pipe line aerial bridge incorporates a basically new design idea that may open the door to even longer and much heavier pipe line suspension bridges. Take a look at the drawing and you will see that the upward camber common to most pipe line suspensions is gone. Instead, the pipe hangs in tension, parallel to the main supporting strands. And it is this tension, believe the designers, that will eliminate all tendency to undulate, sway or "gallop" due to wind or storm action.

Design Theory Gets Prompt Test. Few designers ever saw an idea field tested so promptly and thoroughly. The bridge went in service April 1, and a few days later, a severe squall hit the span. Wind velocity exceeded 70 miles per hour in gusts, yet observers reported that the sway at the center of the span was seemingly less than five feet in amplitude.

In fact, the only damage the bridge sustained in the storm was the loss of eight plastic marker balloons which had been attached to the pipe to attract the attention of aircraft pilots.

Background. Clear Span Engineering Company of Houston designed the bridge for Champlin Oil & Refining Co. The six-inch products line it supports replaced an underwater crossing of the Missouri which was endangered by the scouring river.

The project started about a year ago when Champlin engineers made a survey of this crossing. They found that the river was scouring into the north (South Dakota) bank, and that a failure of the crossing was imminent.

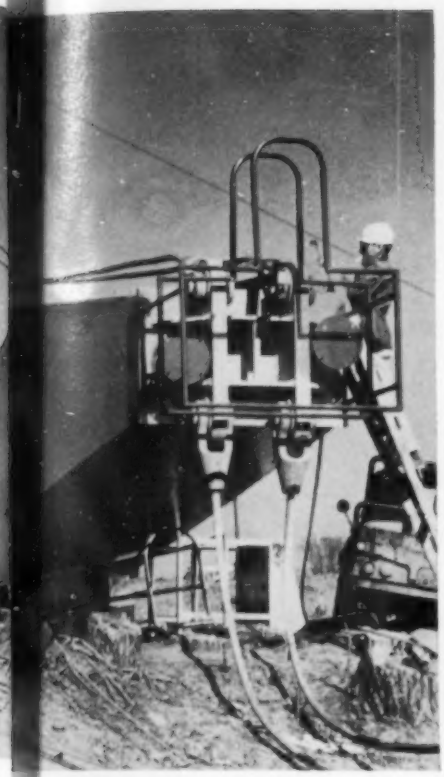
The company had three choices. It could: (1) Lay a new underwater crossing; (2) Lower the existing crossing and extend it about 1,200 feet back into the South Dakota bank; or (3) Construct an aerial crossing.

When Champlin called for proposals on all three methods, the quotations for the overhead crossing were lowest. On this basis, Champlin engineers decided to construct the bridge.

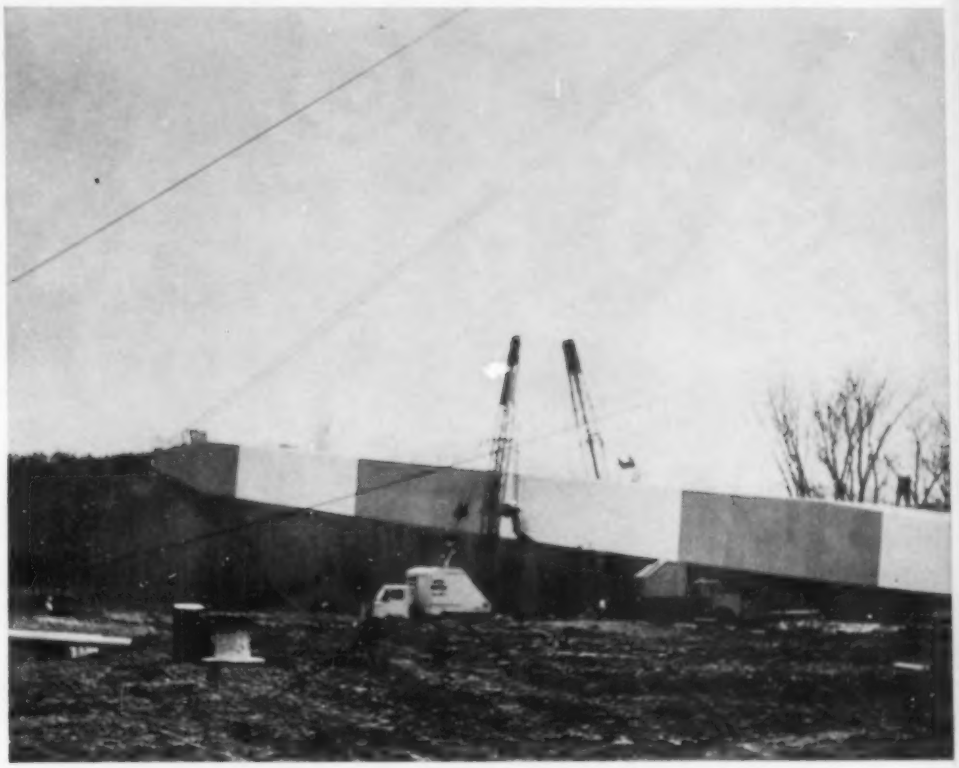
Location. The crossing is on the Missouri River near Ponca, Neb., and Elk Point, S.D., about 30 miles from Sioux City, Iowa. On the Nebraska (south) side there is a 220-foot bluff while the South Dakota (north) side is flat and subject to scouring.

Facts and Figures. Tops of the two towers are at the same elevation. Thanks to a 220-foot bluff on the Nebraska (south) side of the river, the required height of the tower was only 52 feet. On the South Dakota (north) side, the elevation of the tower base is only four feet above the Missouri's high water mark, and the tower height required was 268 feet. An additional five feet was picked up in guard rails and lights, bringing the total height of the tower to 273 feet.

The airline distance between the two towers is 2,703 feet. By way of the pipe line the distance is 2,730 feet, and the two main supporting strands are 2,750 feet.



sheaves atop the gin pole. The two, 2-inch main strands leading off to right are attached to the pipe.



CRANES HELP AT START OF ERECTION. The giant 135-ton tower starts aloft; the pull is upward over the gin pole. Downward pressure on gin pole is 300 tons at this point.

The two main strands are two inches in diameter and galvanized. Their capacity is rated at 490,000 pounds apiece, or a total of 980,000 pounds.

The pipe is six-inch schedule 40 with a wall thickness of 0.260 inches. It was welded up onshore, pulled across the river on ice along with the supporting strands, and hoisted aloft by the towers.

The Remarkable North Tower. By any standards, the design and construction of the 273-foot tower on the north bank of the river was an outstanding engineering feat. It is probably the largest structure ever to be erected in one piece!

Credit for its remarkable structural design goes to Weldon Appelt and the late McCall Fitzpatrick of Clear Span Engineering Company.

The full strength values of the design were assured by the excellent fabrication job performed by The Belmas Company. That fabricating contractor, headed by W. H. (Bill) Mason, has worked closely with Clear Span for several years in perfecting their welding procedure on the internal bracing and connections to the large steel plates.

The weight (150 tons) and size of the tower were fantastic in view of the fact that it was to be pulled erect in such a manner that a considerable part of the force of the pull would be directed along the axis of the tower itself. But, in addition, the six-inch pipe and the two main strands of 2-inch wire rope were attached to the tower during the pull, bringing the total weight to be raised to 190 tons!

The raising of such a structure without permanent deflection and plate buckling was a unique feat. The secret of course lies in its internal bracing. For some time Clear Span Engineering has been turning out beams which have unusual stiffness in relation to weight. One such example is the International Bridge across the Rio Grande at Weslaco, Texas, which Clear Span designed.

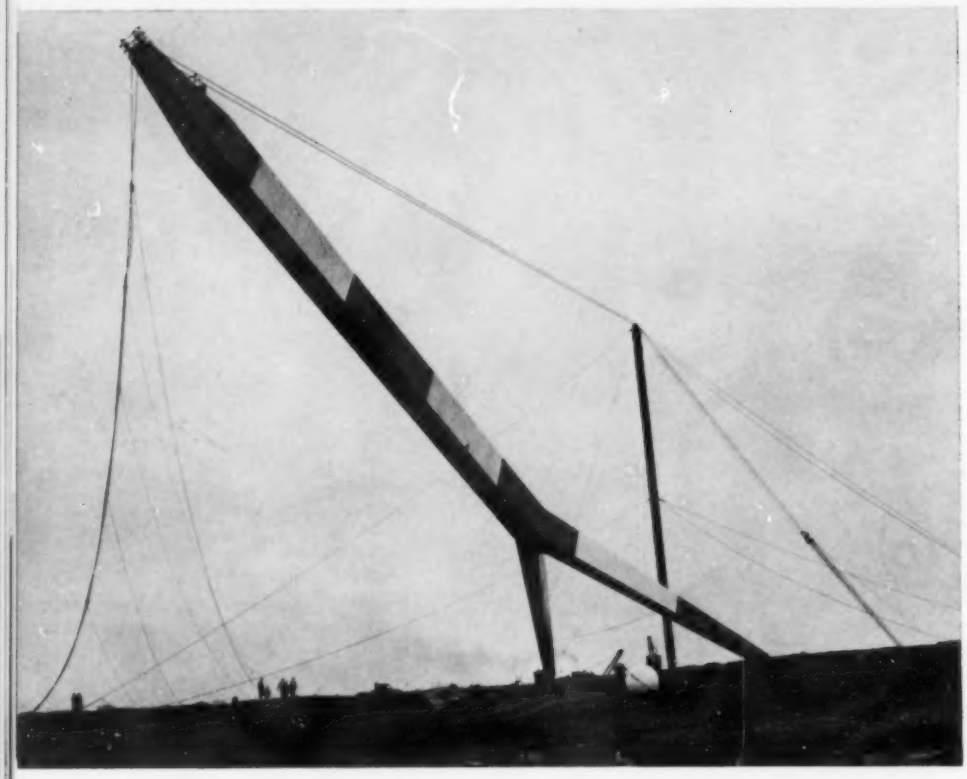
The Dimensions of the Tower Vary. Its greatest cross sectional area is at its "midriff" where it measures 8-feet x 10-feet. Its skin is made of $\frac{7}{16}$-inch steel plate.

How the Tower was Erected. The tower was assembled and welded up on the bank of the river. The two feet were pinned to the clevises in the foundation, and the head lay toward the river. After it was assembled, the main supporting wire rope strands were clamped to the tower head. The six-inch pipe line was connected to the two main strands by suspenders and clamps. The wind guys were also attached to the pipe.

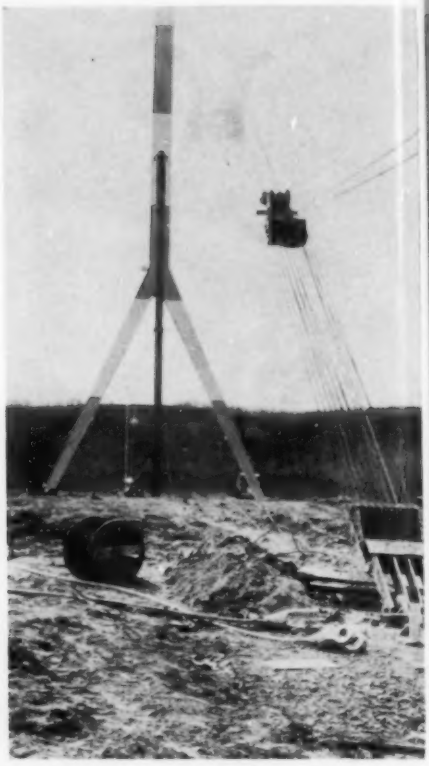
In short, the pipe line crossing was completely pre-fabricated on the ground.

The problem of raising such an assembly was great. Clear Span Sales and LeRoy L. Wade & Son, Inc., performed this work. They were assisted by the supervision and planning of Clear Span Engineering Company. In fact, some of the details of construction were incorporated in the bridge's design—the erection link, for example, made it possible to use the anchor strands for erection of the tower.

Wade & Son fabricated a 36-inch gin pole 120-feet high to bring the tower through the first 40 degrees or so of its 90 degree travel. They poured a special foundation for the pole and fabricated a head for it which had sheaves capable of taking



TOWER AT 30 DEGREES. The two main strands will lift off the sheaves at the top of the 36-inch gin pole as the tower goes higher.



TOWER IS ALMOST ERECT. Blocks exert pull on main strands. Behind upper block is the "erection link" which will be hooked into anchor foundation by two wire rope inserts in foreground.

the 300-ton load that would come during lift off. This head sheave was mounted on a bearing fabricated from $1\frac{11}{16}$-inch diameter by 16-inch long cold rolled shafting around a six-inch solid shaft. The outer race was made of four-inch thick plate 26 inches in diameter, grooved to receive the 2¼-inch anchor strand.

The gin pole was guyed at the top with five 1¼-inch 200-feet long strands secured to dead men. Four belly guys extended outward from a collar welded to the 36-inch pipe at midpoint.

To erect the supine pipe line tower, the two 2¼-inch anchor strands were reeved over the sheaves atop the gin pole. They were clamped to the erection link, shown in the drawings, which in turn was attached to an 18-part block assembly. The latter was powered by a drawworks rated at 65,000-pounds pull.

As the tower came erect, the anchor strands lifted off the sheaves on top of the gin pole as shown.

Erection. Much planning was devoted to the erection of the tower by the designers and one of the ingenious results was an erection link that was used, first, to connect the two main strands to the block assembly, and second, to permanently connect the strands to the rear anchor foundation. To effect the latter, the tower was pulled slightly past top dead center and two pre-cut rear-anchor inserts were pinned to the erection link and to the foundation. This piece is shown in the accompanying drawings.

As the tower came aloft, it pulled the pipe line into proper position above the water. This is about 60 feet above the flood stage of the Missouri. Because all of the suspenders had been pre-cut and clamped to the line, there was necessarily some adjustment prior to final tie-in.

New Design Idea. Pipeliners have always devoted considerable effort to minimizing longitudinal tensile stresses in pipe lines. Traditionally, tie-ins have usually been made in the cool early morning hours, so that the ensuing stresses that would come with temperature changes would be compressive rather than tensile.

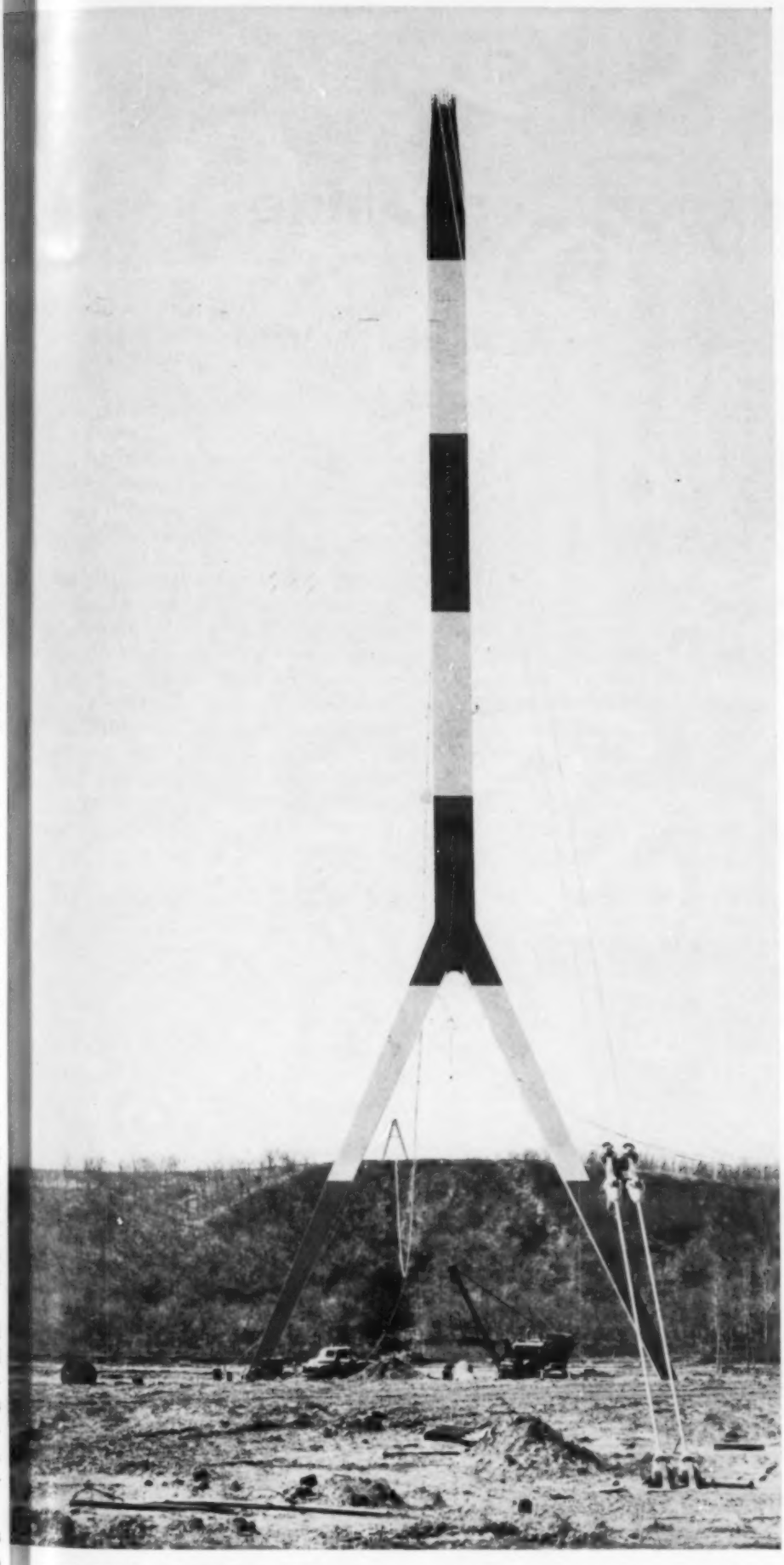
This practice is fine for buried pipe lines—although slack loops, etc. are fast disappearing. Generally, pipeliners simply see to it that the pipe rides high on overbends and stays on the outside of side bends, and let it go at that.

But the practice of using upward camber to eliminate tensile stresses on aerial spans has come under close scrutiny in recent years. For where tensile stresses would tend to hold a line straight, the compressive stresses arising from its own weight, make it flaccid and highly responsive to forces that cause undulation and sway.

Most troubles with aerial spans in the past has been traced to this cause. In one instance, at least, it resulted in failure. One particular line was undulating gently as a result of wind forces when some small boys climbed upon it and started jumping with its movement. The amplitude increased and the line failed in fatigue.

Yet, from the first, designers had thousands of examples of successful and undulation-free aerial suspensions. The electric power industry has always used tension to prevent undesirable movement of its power lines. This has always proved satisfactory—even on the long over-water spans.

Appelt and Fitzpatrick have always used tension in the carrier pipe to prevent sway although, they generally



THE NEWLY ERECTED BRIDGE. Looking at the 220-foot bluff on the Nebraska side, 2,700 feet distant.

followed the practice of having the pipe conform to an upward camber. But, for a crossing of this length, they found that the need for most of the wind guys would be eliminated, if they simply clamped the carrier pipe to the main supporting strands. By calculation, the undesirable effects of the wind could be readily eliminated by a tensile force of 50,000 pounds on the assembly.

The correctness of their reasoning was amply demonstrated when the crossing was subjected to the squall mentioned above.

Foundations. The unusual design of the foundations has been applied to 24 Clear Span bridges of similar construction. Clear Span engineers estimate that the stabilizing legs which jut outward at a 45-degree angle from each bottom corner have resulted in a savings of about one-half the concrete. The legs, which are formed by the soil itself (and poured "neat"), greatly increase the bearing capacity and the overturning moment of the foundations.

The foundation for the large north tower is shown in one of the accompanying drawings. Beneath each leg, there are five 30-ton creosote timber piles capped with the concrete foundation. In addition, four stabilizing legs were formed beneath each leg of the tower, and the two foundations linked together with a four-foot-thick concrete beam which also adds to the bearing capacity of the foundation.

The rear anchor foundation is similar to the others. Note, however, that it has a key notched in the bottom in such a manner as to resist a forward pull. Steel pipe was used to distribute the force of the pull to all of the foundation.

Personnel Involved in the Project. Kenneth C. Cribley, Manager Pipe Line Division of Champlin Oil & Refining Co.; Charles O'Neal, Chief Engineer; Leon Shelton, assistant Chief Engineer; Fred McCoy, Electrical Engineer; Robert S. Crews, assistant Electrical Engineer, supervised the project for Champlin.

Weldon Appelt and McCall Fitzpatrick designed the bridge and represented Clear Span Engineering Co.; Carey Crutcher and Marvin DeWoody had the contract for the construction and erection of the bridge and represented Clear Span Sales Co., Inc. —**The End**

Storing Gas in an Abandoned Coal Mine

Public Service Company of Colorado has stored 750 MMcf in the Leyden Mine near Denver. Plans call for ultimate storage of 3 billion cubic feet

By Robert E. Kelly, Public Service Co. of Colorado, Denver

PUBLIC SERVICE COMPANY OF COLORADO started converting an abandoned coal mine to underground natural gas storage on April 17, 1959. By December 31, 1960, the work had progressed to the point that the mine was holding 750 million cubic feet of gas in storage. Pressure in the mine averages about 200 psig.

The company's present plans call for a continuation of this project with an eye toward an ultimate storage capacity of 3 billion cubic feet.

BACKGROUND OF THE PROJECT

Here is a brief resume of the circumstances which led to our decision to embark on this project:

Gas Supplies. Substantially all of our natural gas is purchased either directly or indirectly from Colorado Interstate Gas Company. Figure 1 shows the principal components of CIG's transmission system. Note that gas from the Four Corners Area is transported through 725 miles of El Paso Natural Gas Co.'s line to Green River, Wyo.; then by Colorado Interstate to the Denver area. The Colorado-Wyoming Gas Co. that serves the area north of Denver is our wholly-owned subsidiary.

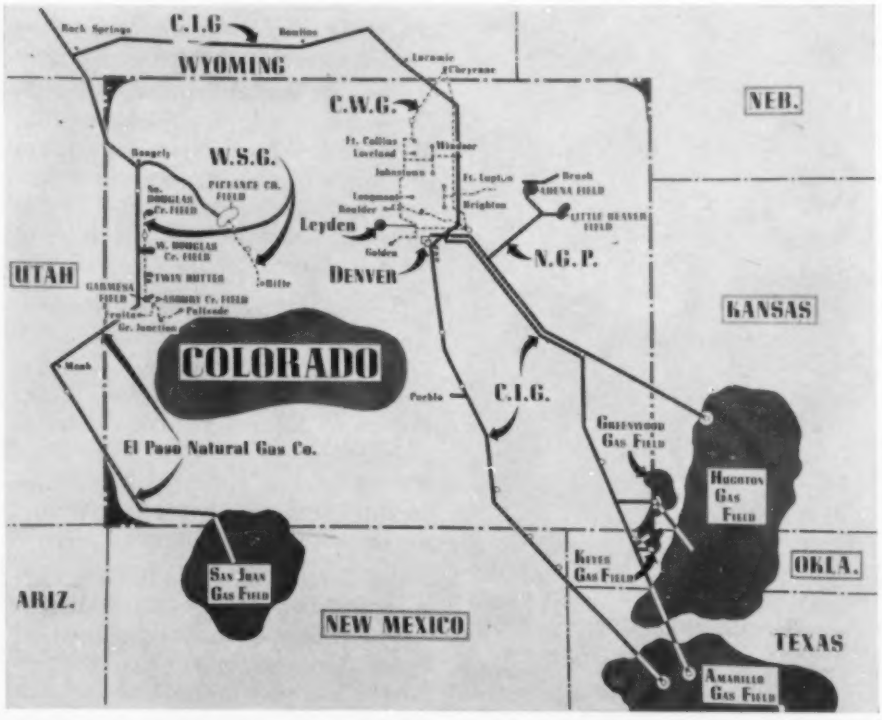


FIGURE 1—Abandoned coal mine 14 miles from Denver is the scene of this innovation in gas storage. From the map, it is obvious that the Leyden Mine is near the center of the major Colorado market area.

FPC Delays Affect Supplies. Between January 1954 and February 1958, Colorado Interstate filed four rate increase applications with the Federal Power Commission. During this period, the Commission was swamped with thousands of rate cases and construction applications. The result was that Colorado Interstate's cases were not resolved separately, but each was piled on top of the other, adding considerably to an already difficult and complex situation.

In 1956, Colorado Interstate completed the last major capacity addition to its system, increasing daily deliveries 117 million cubic feet per day. By summer of 1958, this additional capacity had been so nearly consumed by growth of load that the margin of capacity over system demands had become a matter of great concern. Colorado Interstate, its wholesale customers and other interested parties, agreed to explore the possibilities of a settlement regarding rates. Negotiations were concluded and approved by FPC in December of 1959.

With its rate problems seemingly solved and its earnings situation clearly established, Colorado Interstate filed application with FPC for construction to increase its system capacity substantially. The Commission granted conditional approval last December, but in February, after a review of filed motions, a rehearing was granted so that the timing and nature of final decision in this matter is uncertain at this time.

By means of temporary certification, Colorado Interstate has increased its system capacity to meet its present market requirements. However, in 1958, when our company decided it was necessary to augment its peak day gas supply, there was no assurance of Colorado Interstate's ability to provide additional pipe line capacity in the immediate future.

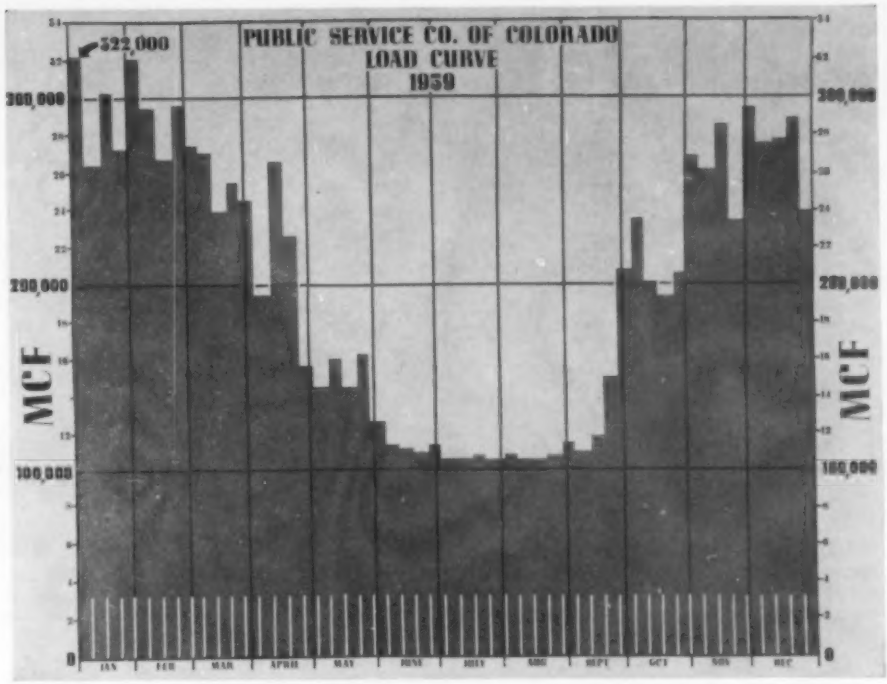


FIGURE 2—Load curve calls for peak shaving. The winter time loads run as much as three times the summer loads; this gives Public Service Company of Colorado an average load factor of about 50 percent. If the coal mine can handle about 3 billion cubic feet of gas the load factor will probably run above 70 percent.

Contract Demand. Public Service Company purchases gas under a Contract Demand form of tariff. It is a two-part rate composed of demand and commodity charges. Currently, one-third of our total cost of gas is included in the demand component. Explanation is our relatively poor load factor which in turn creates a situation that is well suited to so-called peak shaving.

Figure 2 illustrates this point. It shows our actual purchases during 1959, and such a load curve is typical of our present operation. It is apparent that the pipe line capacity required to meet peak winter needs becomes idle capacity during periods of warm weather and with our company this results in a load factor of approximately 50 percent. It is in this area that an operating storage project can make its contribution. By holding the maximum delivery from the pipe line company at a minimum through the use of supplemental storage gas, the load factor can be improved and the average unit cost of gas reduced.

In the event that we are able to develop sustained delivery capacity from our Leyden storage project in the magnitude of 150,000 Mcf per day, our load factor could be increased to approximately 70 percent and the average cost of pipe line gas could be reduced about 9 percent.

Geological Investigations. For these two reasons, our company decided to explore the Denver area for a geologic structure that would be suitable as a storage reservoir. The firm of Ball Associates, consulting geologists, uncovered 16 structures reasonably close to the Denver area, but further study eliminated all but three.

Of the three remaining possibilities, the Leyden mine was chosen because of its proximity to Denver, and because of the fact that a mine cavern would have optimum injection and withdrawal rates as compared with conventional pore storage. These characteristics would not be dependent upon the pore space in the rock formation but rather upon the number of wells drilled into the mine, the size of gathering system and the size compressor station on the discharge line. In addition, the cost of determining the suitability of the mine as an underground storage reservoir is relatively low.

Leyden Mine. The Leyden mine is located 14 miles northwest of Denver (See Figure 1). This mine was operated from 1903 until 1950. As indicated on Figure 3, an east-west elevation, the Leyden mine is in the lower 150 feet of the upper Cretaceous Laramie formation and is in effect two mines consisting of the original workings on the east side and the more recent workings toward the west. The east workings are in what is commonly known as the "A" coal seam and are some 50 feet higher than the new workings which occurred in the "B" coal seam. These seams are located at a depth of 700 to 1,000 feet below the surface and vary from 8 to 10 feet in thickness throughout most of the mined area.

The "Pillar and Chamber" method of mining was used, and the worked out area underlies the major portion of about three sections of land. Because the Laramie formation dips southwest in the Leyden mine at about two degrees, the coal seams at the extreme south end are some 300 feet lower than at the other end two miles to the north.

There are four shafts drilled into the workings. Shafts 1 and 2 are in the east workings and were filled with mine tailings and debris. Shafts Numbers 3 and 4 are in the west workings and are in relatively good condition considering the fact that there has been no maintenance work done on them since the date of abandonment. It should be noted that the only interconnect between the east and west workings is through shaft No. 4 (designated on Figure 3 as "air shaft") which served as a common ventilator shaft for both workings. It should be further noted that the coal seams and the adjacent

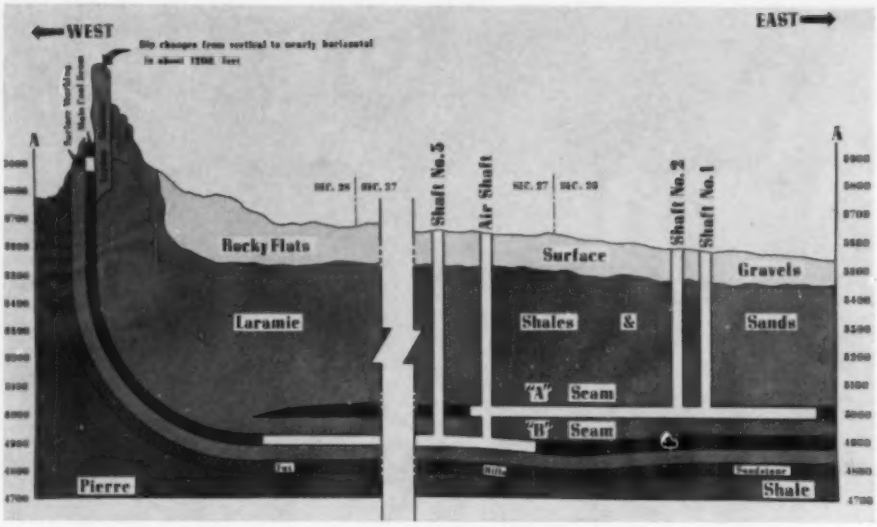


FIGURE 3—East-West section through Leyden mine. Air shaft is common to both sections of the mine. Public Service is trying to seal the interconnection so as to sectionalize the storage. Using water to seal the shafts and injecting into wells drilled at high points in the mine, the company has been able to store as much as 750 million cubic feet of gas.

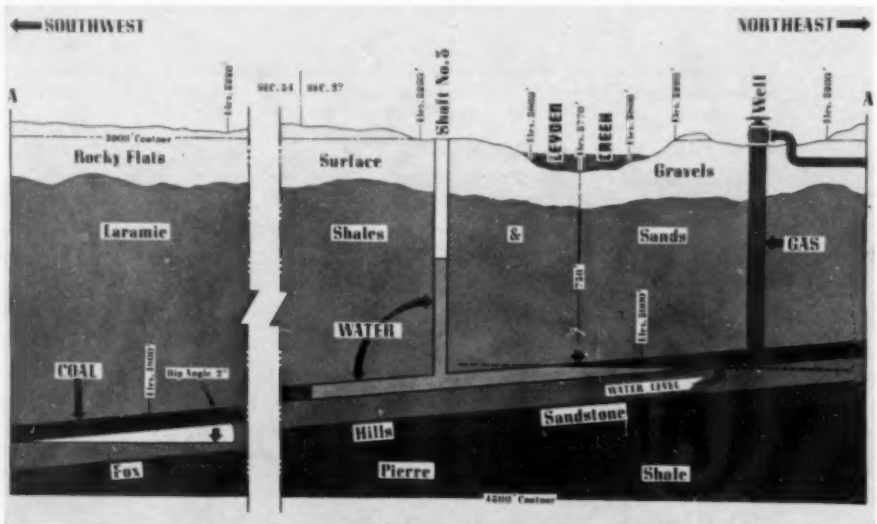


FIGURE 4—Section showing dip explains how water seals were able to contain gas. For future operations, the water seals will be discontinued and the shafts sealed. Ultimate aim is 3 billion cubic feet of gas in storage. Pressure will be 300 psig.

strata above and below them, while nearly horizontal in the mine, fold vertically upward to a surface outcrop about a mile west of the mine.

Capacity. During the period of mining operation, some six million tons of coal were removed from these respective workings leaving a void of 150 million cubic feet. The hydrostatic head of 700 feet indicates a possible safe storage pressure limit of 300 psig and under these conditions the cavern created should contain about 3 billion cubic feet.

Assumptions. Figure 4, a north-south elevation, indicates the conclusion we reached after thorough analysis of the sketchy details we had available. We reasoned that as water encroached into the abandoned mine it had sealed the shafts trapping air, under a minimum head of water pressure, in the structurally high portion of the workings. We further reasoned that by drilling a well into the cavern at the structural high, we could effectively test the upper 20 percent of the mine by taking advantage of the natural "U" tube formed by the four shafts and this well.

Two-Stage Operation. It was decided to approach the development of the Leyden mine storage project in two stages: In the initial test stage, a well was to be drilled into the upper portions of the cavern and, if air were found under pressure, gas was to be piped to that location and injected through the well into the cavern. This would determine the suitability of that portion above the shaft levels as a storage facility under pressure.

Second Stage. Upon completion of the initial test it was intended that we would then enter into the second phase, which would require the sealing of the four shafts and drilling of two large water wells at the structurally low point of the cavern in order to remove the some 3,300 acre feet of water computed to be in these workings.

Drilling. Work was begun April 17, 1959, with the drilling of the Leyden 1 well. During the drilling operation, the bottom 200 feet were cored to determine the nature of the cap rock immediately over the mine. These cores were encouraging. There were sufficient layers and depths of tight clay shales to provide a probably impervious roof. However, this well bottomed out in an unmined area rather than in the cavern as was expected. The accurate locations of coal pillars left in place to support the ceiling of the mine were not available, and it is presumed that this well ended in one of these pillars. The failure of Well 1 was, of course, extremely discouraging.

Leyden 2, approximately 600 feet south of the first location, was drilled in exactly the same manner as Well 1, with the exception that we felt it unnecessary to core drill the 200 feet immediately above the cavern. Here again our choice of drilling location was unfortunate in that this well also bottomed out in an unmined area. **At this point we decided to hydrofrac the two wells and attempt to reach the cavern in this manner. We were successful in fracing out of Well 1 and after three days had pressure in the wellhead in excess of 8 psig clearly indicating that there was a bubble of native air trapped in the structurally high portion of the mine.**

We were not quite so successful with Well 2 and for all practical purposes this well has been abandoned, but since there is some degree of communication between it and the cavern it is now being used merely as a point of pressure observation.

To determine the degree of leakage, if any, before making the appreciable investments in line extensions

for injection gas, portable compressors were utilized to pump some 10,000 Mcf of air into the virgin air bubble discovered at the bottom of Well 1. This volume of injected air built the pressure up to 11 psig which held constant for a period of about two weeks.

While relatively insignificant in magnitude, the pressure results indicated that we did not have a sieve and the evidence thus obtained was sufficient to warrant the drilling of Well 3 into the east workings. This well was completed successfully, so 4½ miles of 18-inch line and 3½ miles of 10-inch line were installed to Wells 1 and 3 from existing transmission facilities.

Injection of natural gas into Well 3 was started immediately at a rate somewhat in excess of 1,000 Mcf per hour. This operation continued on an eight hour per day basis for a period of one week, at which time it was computed that the volume in storage was approximately 50,000 Mcf with a wellhead pressure of 93 pounds. Near the end of the week, this pressure blew the water seal at the No. 4 air shaft which is common to both workings and, as a result, we were forced to blow down or flare approximately 25,000 Mcf in order to relieve the pressure and re-establish the water seal at the shaft.

The evidence of gas tightness in the east workings was sufficiently encouraging that we then drilled Well 4 into the west workings. This well was successfully completed into the cavern and after the injection-withdrawal system was extended to it, we started injecting gas into the east and west workings simultaneously. As of December 31, 1959, we had in storage some 165,000 Mcf at an average pressure of approximately 50 psig.

Compressor Station. This volume of gas in storage was of little or no value unless it could be delivered into the distribution system for use by the ultimate consumer. For this purpose then, we constructed in 1959 a 1,725-horsepower compressor station complete with all necessary auxiliary equipment. This station will eventually be completely automatic and controlled remotely by the Gas Load Dispatching Department in the Denver office.

Early Operation. During the 1959-60 heating season, several trial runs were conducted during which relatively small amounts of gas were delivered into the distribution system. Such tests were successful in uncovering operational difficulties which we had not anticipated.

Additional Development. The objective of the program for the summer and fall of 1960 was to make the minimum storage volumes then developed operational for the 1960-61 heating season. This included drilling and connecting Wells 5 and 6, installing drips and blow-off valves on low points in the injection-withdrawal system and rebuilding wellheads so that in the event of freeze-up remedial action could be accomplished more easily and effectively. Experience gained over the past year and a half indicated the possibility of considerably increasing the pressure on the cavern. So as a part of the 1960 summer program, it was decided to increase the cavern pressure to approximately 250 psig.

Storage Integrity. Our injection program terminated in mid-November of 1960, at which time we had approximately 750,000 Mcf in storage at an average cavern pressure of 200 psig. During the remainder of the year, with the cavern shut in, we continued pressure and water level observations and leakage surveys with both conventional leak detection equipment and a new infra-red leak detector calibrated for methane gas. The results of these observations were very satisfactory in that both pressure and water levels remained relatively constant, indicating that the structurally high portion of the cavern was gas tight. From these findings we concluded that we could successfully develop a minimum storage reservoir and should now proceed into the development phase of the entire mine.

Sealing The Shafts. Before the Leyden mine can be fully developed, the hoisting and ventilating shafts must be successfully sealed. Engineering-wise this will be the most critical phase of the work since of necessity these seals must be gas tight. Engineering of this problem has continued ever since the decision to proceed with the initial test phase of the project. After review of many proposals we decided in favor of the method developed by the firm of Fenix and Scisson. (Figures 5 and 6.)

Figure 5 is a detailed drawing of the No. 3 hoisting shaft. On completion of the cleaning out, the bottom of all three compartments in the shaft will be plugged with concrete to a

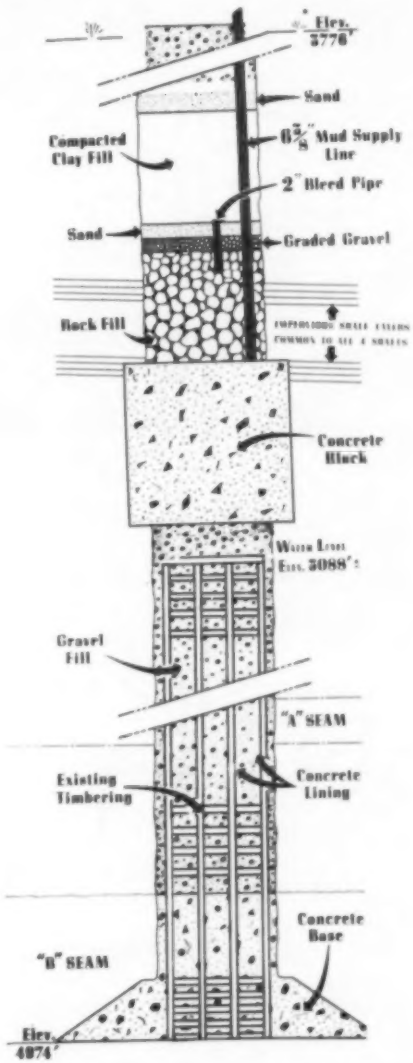


FIGURE 5—Sealing No. 3 shaft. First step in sealing this hoisting shaft will be to plug with concrete for 20 feet above the bottom of the shaft. Next, comes a gravel fill and then the main concrete plug. Rock will be filled on top of this and capped with clay and sand. The mud supply line will enable engineers to pump in 14 to 16-pound mud which will be the real seal of the shaft.

point 20 feet above the bottom of the shaft. This plug will be poured in two lifts of 12 feet and 8 feet each, with a 24-hour waiting period between pours. Next the shaft will be filled to the elevation of the final water level with common bank run gravel. **The main concrete plug** will be poured at this point in three equal lifts of approximately 6 feet each with a 72-hour waiting period between pours. The shaft will then be filled with 50 feet of 3-inch to 6-inch igneous rock, 2 feet of graded rock fill, 4 feet of graded gravel fill, 4 feet of graded sand fill and finally 20 feet of compacted clay. The shaft will be filled with bank run gravel from the top of the compacted clay to surface.

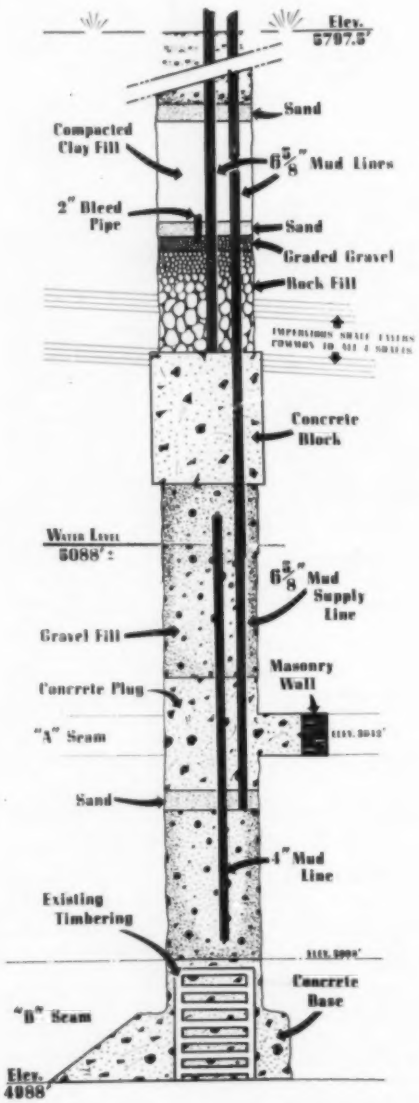


FIGURE 6—Sealing ventilator shaft. This is almost exactly as for No. 3 shaft. However, a masonry wall will be constructed, and a concrete plug poured to separate the two sections of the mine.

Mud Sealant. You will note that the figure indicates a 6⅝-inch mud supply line which terminates in the rock fill between the top of the main concrete plug and the compacted clay plug. Drilling mud—14 to 16 pounds—will be pumped into the void spaces of the rock fill and will act as the sealing agent since the hydrostatic pressure developed will be in excess of the anticipated 300 psig storage pressure and any leakage will be into the cavern. In such an event, mud can be restored as it is dissipated and if excessive, lost circulation material can be added to increase the effectiveness of the sealing agent.

Plugging the Common Air Shaft. The plugging operation will be as described above except that a secondary concrete plug will be poured at the junction of the shaft and the "A" seam in order to effect a seal between the two mines. If this can be accomplished, the two mines can be operated as independent storage reservoirs and add flexibility to our over-all operations.

Shafts Numbers 1 and 2 present a somewhat different problem in that they are filled with debris and must be cleaned out before sealing can begin. After this is accomplished, however, the sealing process will be very similar to that used in Shaft No. 3.

This construction began January 3, 1961, and at the present time work is progressing in all shafts. To date we are at the following stages:

Shaft No. 1—Mucking debris and timbering at 125 feet below surface. Approximately 500 feet remain to be cleaned out before plugging operations can begin.

Shaft No. 2—Mucking debris and timbering at 410 feet below surface. Approximately 215 feet remain to be cleaned out before plugging operations can begin.

Shaft No. 3—Pouring the first lift of the main plug.

Shaft No. 4—Repairing timber at 290 feet below surface. Approximately 335 feet remain to be repaired before plugging operations can begin.

We plan to have all four shafts plugged by the first part of September and all of the work is reasonably on schedule.

Using T. V. In this regard you will probably be interested in knowing that an underwater television camera was used for a preliminary survey of shafts Numbers 3 and 4 to determine their condition before construction was begun.

The main concrete seals just described are to be installed in an impervious zone approximately 40 feet above the "A" coal seam. On January 3, when Fenix and Scisson began work, this zone was under about 300 feet of water and it was therefore necessary to withdraw the gas in the cavern in order to lower the water level. To facilitate this process and meet our time schedule, we drilled three additional wells into the cavern. Wells 7 and 8 are being used as water withdrawal wells at the present time but will later be converted to gas injection-withdrawal wells. Well 9 is in the structurally high section of the west workings and was completed as a gas well.

From mid-January to date, we have withdrawn 573,000 Mcf of gas and 103 million gallons of water. We are still pumping some water from the west side but largely to keep up with the natural seepage into the mine.

Beginning in September, after the shafts have been sealed, re-injection of gas under line pressure will begin, to effectuate recharging the reservoir with approximately the same 750,000 Mcf of gas which was in storage as of December 31, 1960.

The possibility should be recognized that the sealing of these shafts may not be successfully concluded. In that event, water will be pumped back into the mine to re-establish the water seal at the bases of shafts and future operation will then be limited to the 750,000 Mcf level. Even in that event of minimum operation the mine can prove to be economically feasible.

If, as hoped and expected, the shafts can be successfully sealed, continued testing will occur, aimed at

eventual entire replacement of mine water with gas. Such testing could conceivably become extended over the next four or five years. The basic process will involve withdrawal of water so as to expose incremental cavern volumes, each increment of water removal being accompanied by incremental additions of gas to appropriate levels of pressure. In the event uncontrollable leakage is discovered at any stage in the succession of test intervals, mine water will be re-introduced to restore the water seal and the project will terminate at that point. We intend, of course, to utilize every engineering skill to develop the mine to its ultimate capability of 3 million Mcf of storage gas.

ACKNOWLEDGEMENT

From a paper presented at the American Gas Association Transmission Conference, Denver, May 26, 1961.

About the Author

Robert E. Kelly, staff engineer assistant to the vice president of gas operations of Public Service Company of Colorado, has been close to both the engineering and the construction of underground gas storage in "retired" coal mines. Kelly has been with Public Service since 1946 when he was employed as an assistant engineer in gas utilization engineering. Since that time he has had duties as an engineer and as a supervising engineer in gas supply engineering prior to his present assignment in 1959. Kelly holds a B.S. degree in chemistry from Regis College, Denver. Prior to, and during World War II, he completed various engineering and ordnance chemistry assignments with Remington Arms Company, DuPont, the Denver Ordnance Plant and at the Hanford Engineering Works at Hanford, Wash. He is a registered professional engineer in Colorado and a member of the American Gas Association and the Rocky Mountain Gas Association.

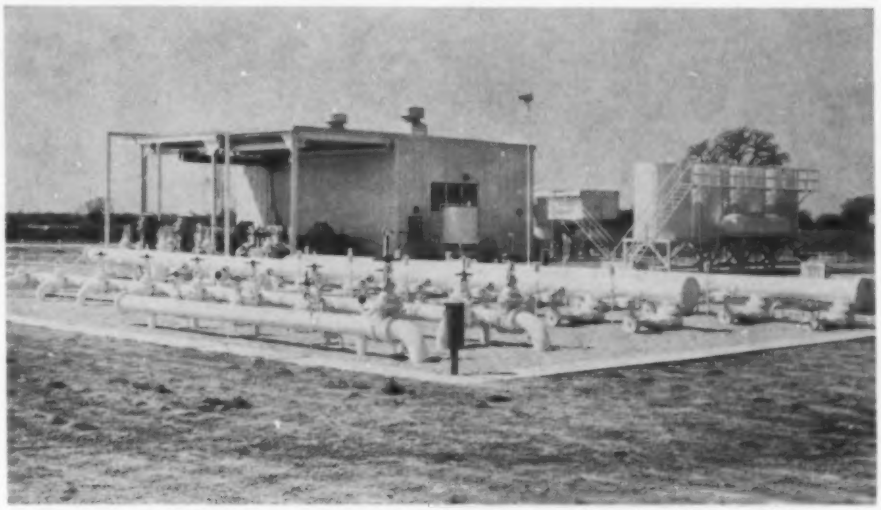


Photo Courtesy of Nordberg Manufacturing Company

Lonesome one-man station has 4,000 hp. The Teague, Texas station is at midpoint on Sinclair's 304-mile 18-20-inch line from Jacksboro, Texas to Houston. Load factor may vary as much as 40 percent in a day.

Sinclair's One-Man Station Saves Money

The two 2,000-hp dual fuel diesels are pushbutton controlled locally

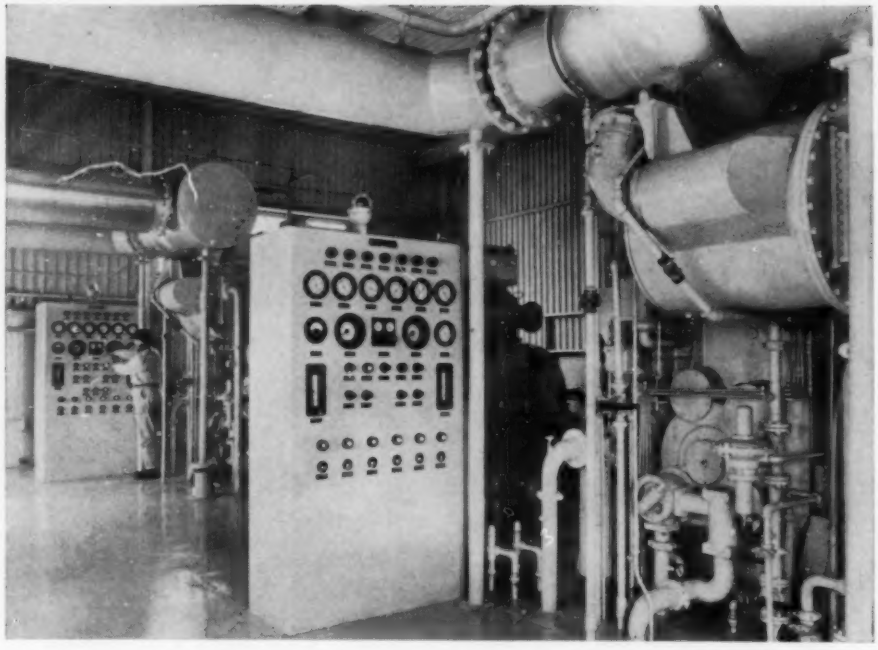
TWO ELECTRICALLY-CONTROLLED dual-fuel diesels are providing high efficiency pumping power at Sinclair Pipe Line Company's Teague, Texas, pump station. Despite the fact that the load fluctuates as much as 20,000 bpd, varying the load factor from 60 to 100 percent, the fuel cost has been just 2.1 mills per horsepower-hour, or 0.51 mills per barrel pumped.

Engine controls have been arranged for one-man station operation for the present and possible remote control in the future. Because breakout tankage is required for incoming crude, the station is presently being manned. If Sinclair eventually switches to remote microwave control, the only purpose will be to give the dispatcher at Independence, Kan., closer control of pipe line flow.

Location. The Teague station is at mid-point on Sinclair's 18-20-inch line that carries crude from Jacksboro in West Texas to the company's refinery and tanker loading facilities at Houston. The 152-mile incoming Jacksboro line is 18-inch, and there is a 90-mile 12-inch line coming in from East Texas. The 152-mile Teague-to-Houston line is 20-inch.

Tankage. All incoming oil is tanked at Teague. There are five 120,000-barrel tanks and six 55,000-barrel tanks with a total capacity of 930,000 barrels. The oil is dispatched from tankage to the refinery at Houston or directly into a waiting tanker there.

Why engines? Sinclair engineers felt the engines provided an inherent flexibility and operating economy at all



Control panels are designed for one-man operation. Tank switching, starting and stopping booster pumps, etc. are push-button controlled.

contemplated pumping rates. Calculated savings in operating costs as compared with electric drive were sufficient to pay for the equipment within the station's life, Variable load was a major factor, too. The pipe line pumping rate is greatly increased when a tanker is loading or when there is crude in the line which is destined for a tanker.

These periods of high rate pumping occur two or three times a week for normal tanker schedules. With electric units, Sinclair engineers felt that this increased pumping rate of short duration would add greatly to the electric demand charge, increasing the average cost of pumping.

Engines. The two engines, which are dual-fuel, four-cycle, eight-cylinder, 13 x 16½, in-line turbo charged diesels develop 2,000 hp each at 514 rpm. They drive 8-inch centrifugal pumps and each engine is connected to its pump through a flexible coupling, a speed-increasing gear with a ratio of 4.28 to 1 and a flexible gear-type coupling with spacer between the pump and gear.

Pumps. At 2,200 rpm, the three-stage, 8-inch pumps are rated at 5,400 gpm (185,000 bpd) at 1,380-foot head (500 psig—38° API). One pump with engine at full 514 rpm can develop 720 psig discharge. In series, with engines at 440 rpm, two pumps develop 1,000 psi.

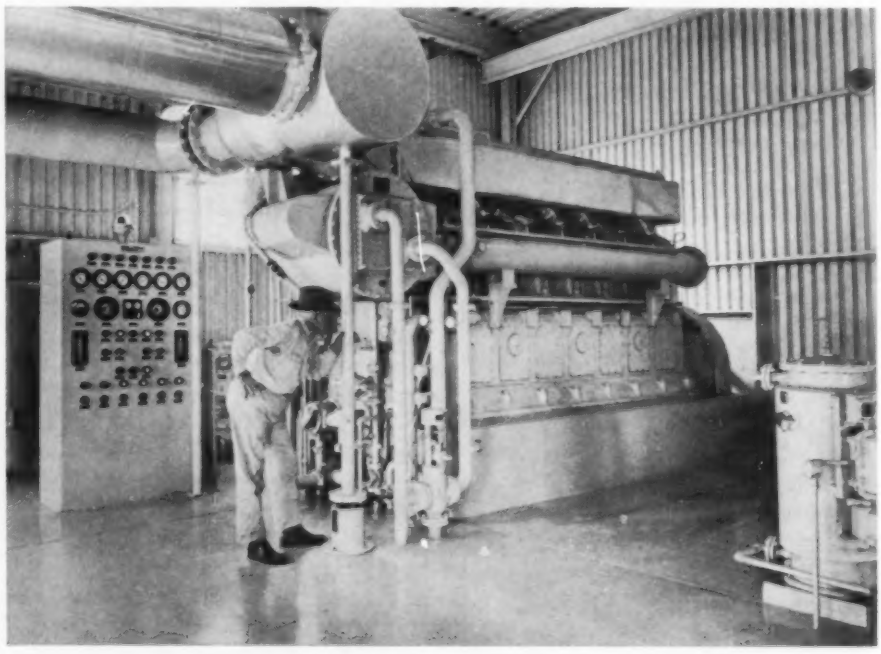
The building is a metal fabricated building with gears and pumps outside under a lean-to roof. The wall between the engines and gears is constructed as a fire wall.

Electric Booster Pumps. Two 100-hp motor-driven booster pumps supply crude oil from the tank farm to the main-line pump suctions at 50 psi. Only one booster runs at a time; the other serves as a standby.

Auxiliary Equipment. Virtually all auxiliary equipment at Teague is electrically driven in order to reserve all possible engine power for pipe line pumping. Exceptions are the engine lube oil pumps and the accessory lube pumps. The latter are driven off the speed increasers. Both of these lube systems have electrically driven before-and-after pumps which also serve as automatic standby units.

Engine Fuels. The engines will operate on diesel fuel, crude oil or natural gas with either diesel or crude as a pilot fuel. For best economy, clean operation and minimum maintenance, the preferred combination is natural gas with diesel oil as pilot fuel.

Fuel Handling and Transfer. The fuel oil is transferred from storage by a meter-driven pump through filters to a header supplying both engines. When crude is used, the filtered oil goes through the filters twice. Natural gas passes through a scrubber to a common header which supplies each engine through its governor-controlled gas regulator.



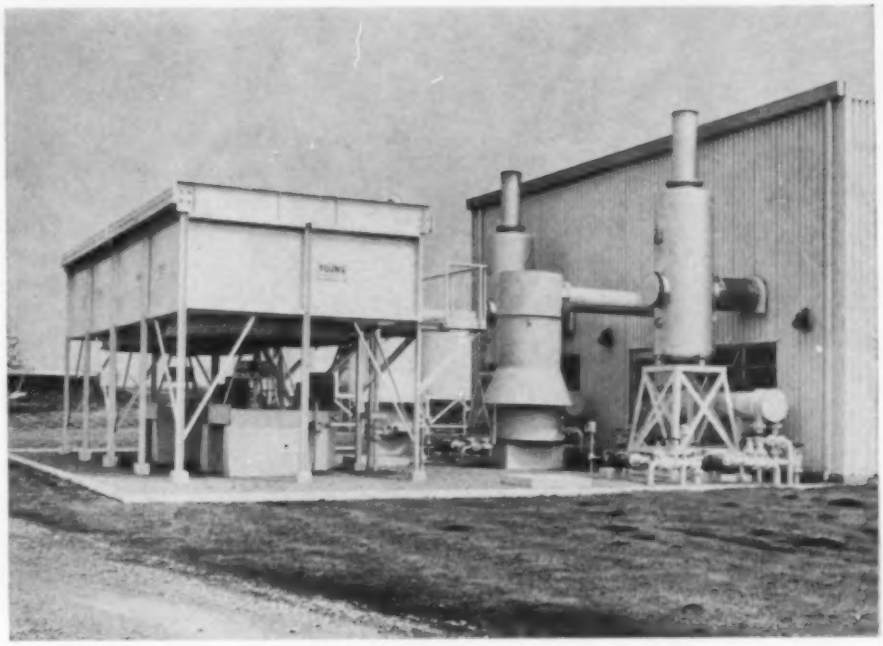
One of the 2,000-hp dual fuel engines. For normal operation, the station uses natural gas with diesel fuel as a pilot fuel. Pump and speed increaser are outside the building.

Normal practice is to start the engine on oil, then switch to dual fuel.

Cooling system. Each engine has its own closed cooling water system. It is equipped with a fan-cooled radiator, electrically-driven jacket water and jacket water balancing pumps. The surge tank is common to both engines, and either radiator can be used with either engine. Temperature control is automatic.

Radiator fans are driven by two-speed motors, automatically controlled to regulate water temperature. Thermostatic valves direct as much cooling water as required through the engine intercooler, engine lube oil cooler and lube system cooler.

Engine air comes through oil bath filters, then the exhaust-driven turbocharger and the intercooler. Exhaust gases turn the turbocharger, then vent through vertical silencers.



At rear of station is cooling equipment, heat exchangers and intake and exhaust silencers.

CONTROLS FOR ONE-MAN OPERATION

At present the engines are started by the operator from a panel in the engine room. First, he fingers push-button controls that start the motor-driven engine auxiliaries such as lube water and fuel pumps. Next, he presses a pre-start button and a light comes on to announce that the cooling water, lube and fuel pressures are up and the suction pressure to the main pipe line pump is adequate. Then he pushes the start button, and the engine fires.

Another button switches the diesel from straight oil to dual-fuel operation.

Engine Speed Control. The engines are equipped with pneumatically operated governors, and engine speed can be controlled manually from either the individual engine-room panels or from the control building 70 feet away. Normally, the engine speed is controlled automatically by pipe line flow or pressure. Controls are set on the main control panel for the desired volume of flow, high discharge line pressure and low suction pressure. The engines run as fast as necessary to provide the indicated flow volume, but the pressure settings can override the volume control to keep suction pressure above the set minimum and discharge pressure below the prescribed maximum.

Discharge pressure primarily determines the engine speed, subject, of course, to low suction pressure override. However, volume control—rather than discharge pressure—would be the preferred setting. The controls are electronic and convert to pneumatic actuators to regulate the governor settings.

From the main control board, the operator can handle virtually all aspects of station operation other than engine starting. He can start or stop booster pumps, regulate engine speed, open or close the suction and discharge valves, open or close the main line valve, start or stop mixers in each storage tank on the farm, control motor-operated valves to direct flow of crude into or out of any tank.

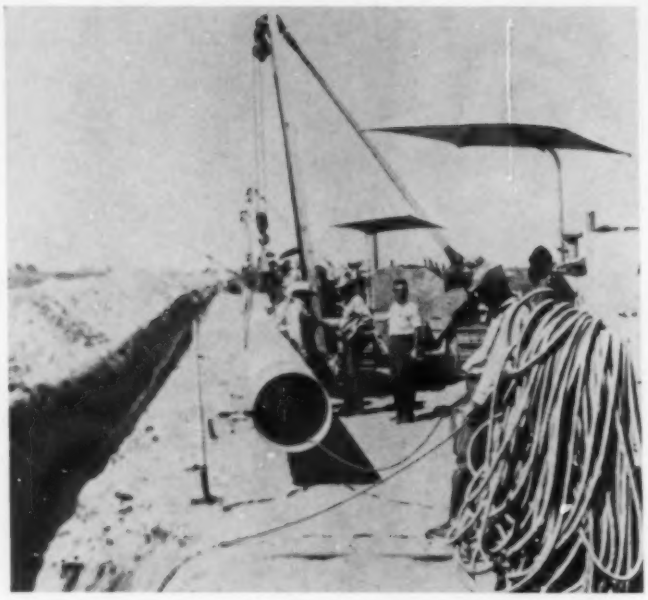
Alarms. A complete alarm and automatic shutdown system with a full annunciator panel in the control room provides the station with a high degree of protection against damage from abnormal operating conditions. For some conditions, alarms warn the operator of approaching trouble and give him time to correct the condition and avert a shutdown. Examples of this type action are: *excessive seal leakage, high jacket water temperature, low lube oil pressure, low accessory lube oil pressure, low pilot fuel pressure, high lube temperature, low starting or control air pressure and engine overspeed.* In each case, if the trouble is not corrected and approaches the danger level, the engine shuts down automatically and the annunciator panel indicates the cause of shutdown.

Shutdowns. In addition, automatic shutdown devices are provided for: *low pump suction pressure, high pipe line discharge pressure, low voltage, and high temperature in a pump bearing, pump case or speed increaser bearing.* A panel incorporated in the control board enables the operator to get a temperature reading on these bearings and pump cases to determine which caused the shutdown after the annunciator indicates this temperature group as the seat of trouble. In all other cases, the annunciator specifies directly the cause of the shutdown.

Operating History. The station started operations in March 1959 and despite the unusual demands of high load factor followed by low load factor, the station has maintained low operating costs and high fuel efficiency. The instrumentation and controls have proved satisfactory, and the over-all economy is excellent.

ACKNOWLEDGMENT

Photographs and technical data courtesy Nordberg Manufacturing Company, Milwaukee, Wis.



Air-supply hose runs deep inside the concrete-lined pipe line. Inside, a slim-hipped pipeliner is sealing joints at welds with special plastic material which was mixed and quick-frozen before it was brought to job.

Plastic material is loaded into polyethylene tubes, then placed in quick-freeze where temperature is carried to 60° F below zero! Plastic is then hauled to job in refrigerated container. Five miles of these tubes were used by R. H. Fulton on Gulf Oil's West Texas salt-water line.

Deep Freeze Extends Pot Life of Internal Sealant

To seal joints of a concrete-lined West Texas pipe line, the contractor used quick-frozen plastic material

At the end of the air hose is the slim-hipped pipeliner scooting along on a concave creeper. The air hose supplies his breathing mask and an air-actuated caulking gun is used to apply the sealant at the joints.

IT TOOK MEN who were lean-of-hip and not subject to claustrophobia to apply the internal sealant to the joints of Gulf Oil Company's concrete-lined water injection pipe line in West Texas. For the men had to move back into the pipe line some 360 feet on concave creepers, and apply plastic sealant to the gap at the end of each 120-foot section of pipe.

The pipe line was laid to handle formation water containing hydrogen sulfide. To protect the steel pipe, a high-density internal concrete coating was applied to the triple-jointed sections of pipe. But to preserve the integrity of the internal coating, the weld area at each 120-foot section had to be coated. For this job, the company selected a catalyst-actuated plastic sealant. While this material was ideal for the job, it had the limitation of a short pot life.

Here, the ingenuity of a pipeliner solved the problem. For contractor R. H. Fulton & Co. decided to premix the sealant at a Kermit, Texas, warehouse, deep-freeze it to 60°F below zero and transport it to the job in a daily batch.

The reason quick freezing was required, was that when the fresh-mixed plastic was subjected to a slow freeze, the outside solidified, forming an insulation that greatly retarded the internal chilling. Thus, the pot-life of the interior portion of the sealant was shortened.

Prior to quick-freezing, the sealant was poured into plastic tubes which would fit an air-actuated caulking gun.

In the field, the pipe gang lined up and welded three of the 120-foot sections of pipe. Then the slim pipeliner entered the pipe, equipped with an air mask, an air-actuated caulking gun and a miner's lamp, scooted along on the creeper for a distance of 360 feet and started to work. He coated all three of the gaps before he returned to the outside.—**The End**

Pump N_S=1600, N=3585 rpm			
Fluid	Temp. °F	NPSH, ft. Min. accuracy ± 0.5 ft.	Δ NPSH
Water	70 250 300	12.3 11.0 8.6	0.0 1.3 3.7
Butane	35 55 90	9.8 8.8 3.5	2.5 3.5 8.8
Butane + 3 % Propane By Wt.	35 55 90	9.5 7.8 1.6	2.8 4.5 10.7
Benzene	180 230	12.4 9.7	(-0.1) 2.6
Kerosine/Degas	70	12.4	(-0.1)
Gasoline (Reid)	70	13.3	(-1.0)
Freon-11	85 120	10.2 8.4	2.1 3.9
Pump N_S = 1200, N = 3585 rpm			
Water	70 290 325 410[a]	12.0 9.5 6.0 2.0	0 2.5 6.0 10.0
[a] Extrapolated From Lower Capacity			

FIGURE 1—Laboratory test results, NPSH requirements at design flow and 3 percent drop in head.

What Engineers Should Know About Cavitation And NPSH

. . . to make economical pump selection. This new data and theory are aimed at accurate prediction of pump suction requirements for all liquids on the basis of cold water requirements

By Victor Salemann,* Test Engineer
Worthington Corporation

TO MAKE AN ECONOMICAL selection of a pump, you must have knowledge of NPSH (Net Positive Suction Head) provided by the system and the minimum NPSH which will guarantee a certain performance. Liquid mixtures and dissolved gases affect available NPSH because of their variable vapor pressure. Required NPSH is affected by desired pump performance, thermodynamic properties of the fluid and also by composition of liquid and vapor during cavitation.

A relationship between pump suction characteristics and fluid properties has been obtained in our research laboratory work. Satisfactory performance of pumps on hydrocarbons with less NPSH available than required by cold water was studied. The data collected and theory developed aim at accurate prediction of pump suction requirements for all liquids, on the basis of cold water requirements.

Some of the results of this research can be applied in selecting pumps for satisfactory cavitating operation at reduced available NPSH, representing a direct first-cost saving. A less tangible saving is in the elimination of a good portion of misapplication due to lack of information and oversimplified correction factors.

This pump application research is vitally important to all users of pumps handling hot water, hydrocarbons, liquefied gases and other liquids. It is of special value to those handling mixtures of liquids with dissolved gases.

Experimental work included cavitating performance tests on water up to 400° F, pure butane, butane-propane mixtures, benzene, Freon 11, gasoline and kerosene; all at several temperatures. Results were correlated on the basis of fluid properties and pump characteristics. Particular attention was paid to hydrocarbon mixtures and the effect of the variable vapor pressure of mixtures on the available NPSH and the cavitating performance of the pump.[1]

Cavitation—Its results. Why is cavitation important to the pump user? You're likely to find:

1. Loss of performance—decrease in head and efficiency at equal flow.
2. Higher flow demand results in

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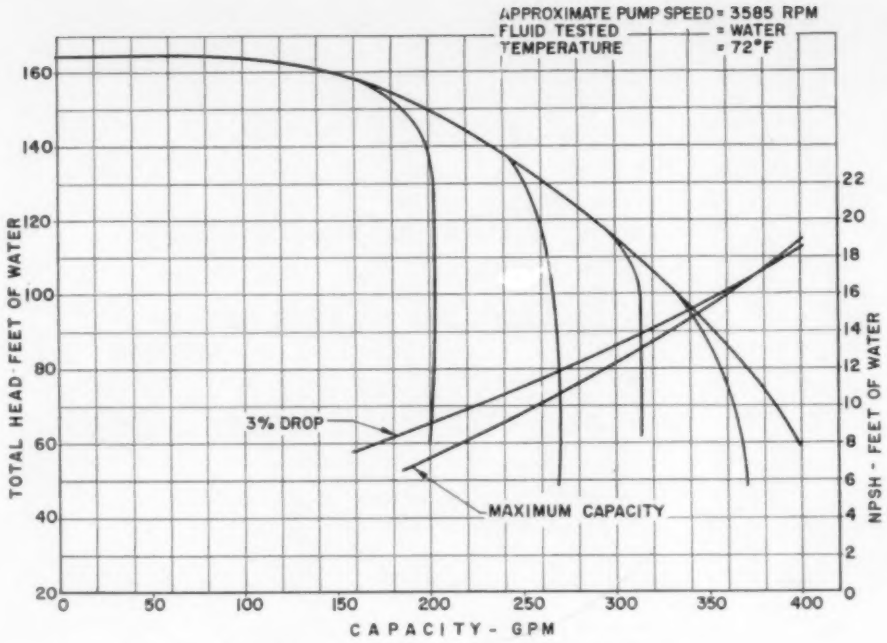

FIGURE 2—Cold water cavitating performance.

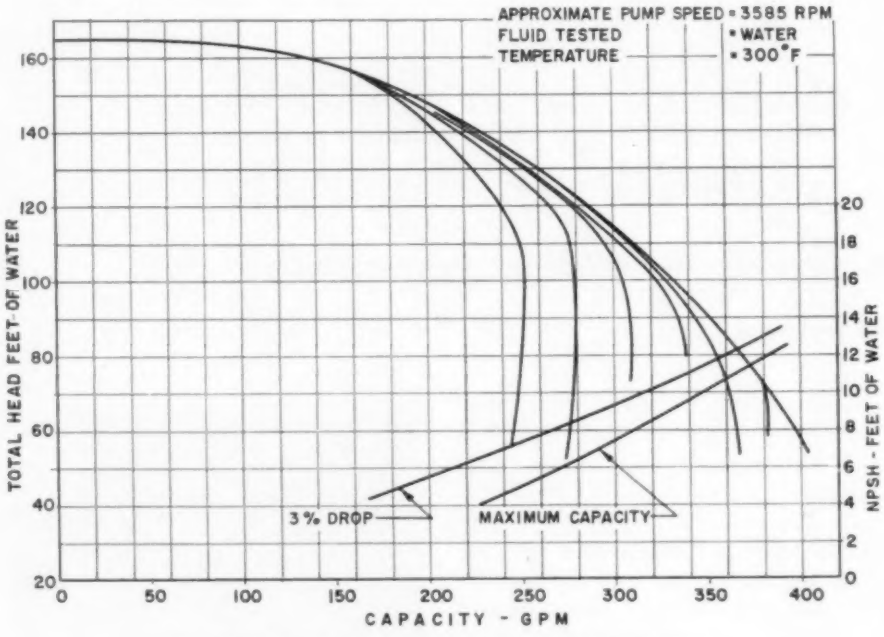

FIGURE 3—Cavitating performance of 300° F water.

further loss of performance or cannot be satisfied at all.

3. Noise and vibration of pump and piping.

4. Non-steady pump operation, resulting in pressure surging and shaking forces on pump and piping.

5. Mechanical damage to waterway boundaries—impeller pitting near the suction is common, but may occur near discharge tips and on parts of the casing, such as tongue and suction nozzle.

Summing up, cavitation adversely affects hydraulic performance, mechanical performance, and parts life.

The Cavitation Process. First, what is "cavitation?" It is frequently used synonymously with any one of the effects listed above. We will use it to describe only formation of cavities in the liquid and not performance drop or physical damage. A "cavity," actually filled with the vapor or gas from the surrounding liquid, forms when the pressure in the liquid drops below its vapor pressure. The process is quite similar to boiling, where heat raises the vapor pressure above ambient pressure.

A cavity may be formed in a liquid by completely filling a piston-equipped cylinder and then pulling on the piston until the liquid ruptures and a vapor-filled cavity appears.

Liquid cavitation may also be produced locally by dynamic means. An object can move through liquid at a velocity so high that the liquid does not "close" immediately behind the object—for example, a vane moving through water such as a propeller or impeller blade. Cavitation is also possible when liquid flows through a contracting passage, as a venturi. In this case the downstream side applies a vacuum to the liquid at the throat until the liquid reaches its vapor pressure and ruptures. The low pressure is produced by the acceleration of the liquid as it moves through the contracting passage or into space vacated behind the moving object—as the kinetic energy increases due to increased velocity, potential energy (pressure) must drop an equivalent amount.

NPSH and Cavitation. This brings us to NPSH and its relation to cavitation:

NPSH is the sum of kinetic and potential energy of the liquid approaching an object over and above the potential energy needed to keep the medium in a liquid state; that is, over the vapor pressure. Use of NPSH need not be confined to pumps and turbines. It is not a characteristic of the machine, but rather of the liquid steam. To avoid confusion, it should be called *available NPSH*.

As available NPSH goes down, a point is reached where cavitation appears on the object studied, whether it is a stationary hydrofoil or a moving vane. The NPSH corresponding to the appearance or disappearance of the first vapor bubble, to the first measurable drop in turbomachine performance, or the onset of noise attributed to cavitation, is called *minimum required NPSH*. This quantity is a characteristic of the machine and its operating conditions. It is usually considered as independent of the liquid, its pressure, velocity, vapor pressure and other properties.

For some time, the Hydraulic Institute has recognized that when hydro-

carbons are handled, minimum required NPSH depends on liquid properties.

Our research work has shown that, depending on definition, the NPSH always depends on liquid properties.

However, let us dwell a little longer on minimum required NPSH. We have seen that it is the minimum energy, above vapor pressure energy, that must be contained in the liquid approaching the pump, that will prevent cavitation or its symptoms. In equation form, it is expressed this way:

$$\text{NPSH} = P_{\text{st abs}} - P_{\text{vapor}} + \frac{V^2}{2g} \text{ (ft.)}$$

For a given pump and operating condition, velocity head is constant. If the pump needs a certain NPSH, this value can be obtained by an infinite number of combinations of static pressure and vapor pressure. For example, at sea level, atmospheric pressure on the surface of cold water provides approximately 34 feet NPSH. A pump requiring 10 feet NPSH could be placed 24 feet above the water level (neglecting friction losses) and would operate cavitation-free. However, the same pump would have to be placed 10 feet below the surface in an open, boiling tank of water. Here, the vapor pressure at the liquid surface equals the atmospheric pressure; therefore, if the liquid temperature is uniform throughout, the 10 feet total energy above the vapor pressure must be provided for by 10 feet *submergence.*

Temperature Up—Minimum NPSH Down. Can a pump running on water at 300° F operate satisfactorily with less available NPSH than minimum required? The answer is in the definition of "satisfactory" and "minimum required." If "satisfactory" operation is taken to mean negligible hydraulic performance loss, good mechanical performance, lack of noise and cavitation damage, then the pump can operate on less NPSH than the minimum established by a cold water test. Yes, it is cavitating, in the sense that vapor forms at the suction blades and is recompressed into liquid on its way through the impeller. But, due to thermodynamic properties of hot water, only a very small vapor volume is created by a moderate reduction in NPSH below the cold water minimum. Evaporation, however, requires heat. Since this comes from the liquid surrounding the vapor, the whole fluid cools slightly. This temperature drop lowers the cavity vapor pressure so that it is no longer above the local static pressure—and evaporation stops. Thus, the cavitation process is self-limiting.

In cold water, an infinitesimal drop of available NPSH below minimum required releases a sufficient volume of vapor to affect hydraulic performance. Due to this quick response to a very small pressure differential, evaporation occurs only locally or intermittently. It produces mechanical vibration; and sudden collapse of the cavities filled with only a very light vapor causes noise and mechanical damage. At 300° F however, a pressure drop of several feet below required minimum is necessary before water develops enough vapor by volume to measurably affect pump performance. This large depression tends to create a more uniform distribution of vapor, allowing the pump to operate smoothly. The relatively

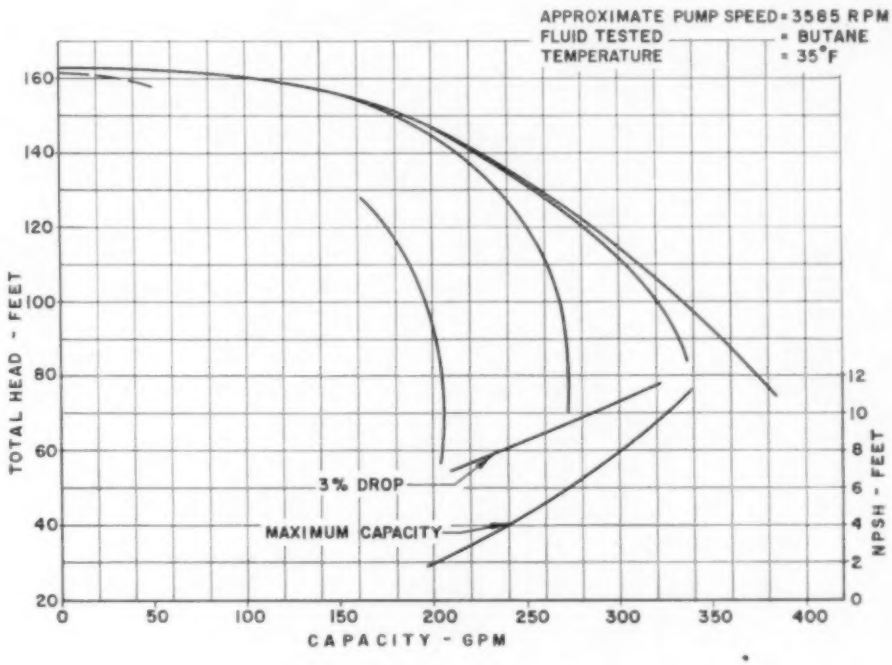

FIGURE 4—Cavitating performance of butane at 35° F.

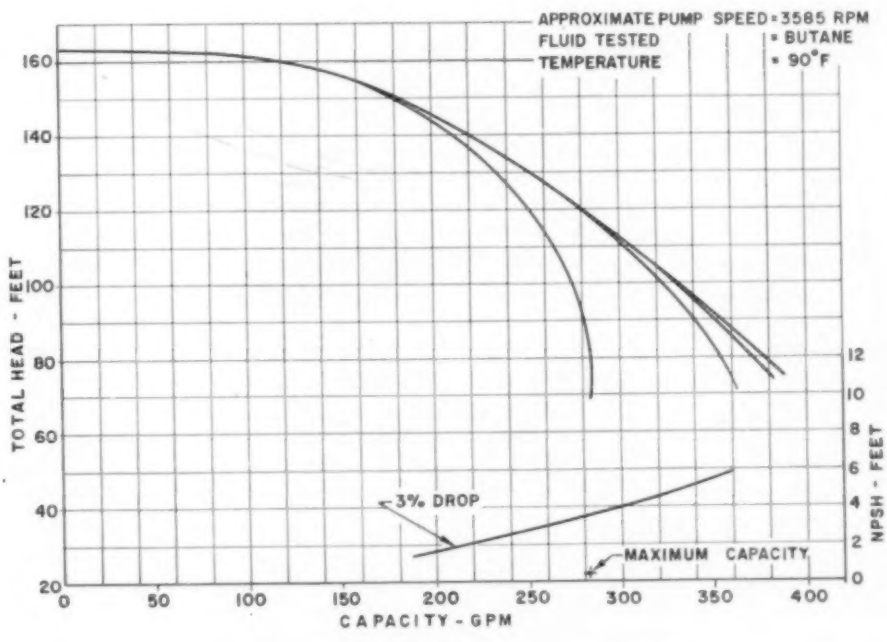

FIGURE 5—Cavitating performance of butane at 90° F.

high density of the vapor at 300° F and 67 psia slows down bubble collapse as it travels into a high-pressure region, reducing noise and erosion damage.

We conclude that if cavitation is to be absolutely prevented, a pump requires the same minimum NPSH regardless of liquid properties. If, however, the operator will settle for avoiding most cavitation effects (even though cavitation exists in the pump), then some liquids require less NPSH than others. Since cavitation effects set in with cold water almost as soon as cavitation starts (and since cold water is readily available), other liquids and hot water are usually compared to cold water as a standard.

Tests Relate Minimum Required NPSH to Temperature.—*Point to Vapor Pressure as Major Influence.*

A condensation of test results, in terms of minimum NPSH for maintaining 97 percent of non-cavitating head, is given in Figure 1. Typical test curves are shown in Figure 2 and Figure 3 for water at 70° F and 300° F; and for 99.5 percent pure butane at 35° and 90° F in Figure 4 and Figure 5. The NPSH curves are plotted through points representing a 3 percent difference between the non-cavitating head and cavitating head at the same capacity. Observe how the break-off curves, representing pump performance at varying constant available-NPSH values, become more gentle as temperature is raised.

Theoretically, all should begin break-off at the same NPSH point. However, the break-off curves are more gradual at higher temperatures, and the arbitrary 3 percent difference appears at higher capacity. The NPSH curve based on a 3 percent drop therefore moves to the right, reducing NPSH requirements at all capacities by about the same amount.

Figure 6 is the main correlation plot on which test results for all liquids and both pumps are shown. The parameter V′ is defined as follows

$$V' = \frac{\text{Vol. of Vapor}}{\text{Total Volume}}$$

This volume ratio is assumed to be produced at the low pressure point in the impeller by a pressure drop below vapor pressure equal to the measured NPSH reduction as compared to cold water. Dr. Stepanoff[2] uses the similar parameter

$$B = \frac{\text{Vol. of Vapor}}{\text{Vol. Liquid}}$$

calculated under the same assumptions he presented more test results and proposes a correlation against suction specific speed.

Figures 7 and 8 illustrate NPSH reduction versus temperature for water and NPSH reduction against vapor pressure for butane and butane-propane mixtures. The latter is expected to be applicable to homologues of the Methane-Ethane-Propane series and those unsaturated or similar compounds whose physical properties, taken at the same vapor pressure, are similar in magnitude. Vapor pressure is chosen as the "common denominator" because it controls the density of the vapor to a large degree. Vapor pressure, therefore, controls a key parameter in cavitating pump performance; that is, the specific volume ratio of vapor to liquid. Other important properties, such as the slope of the pressure-enthalpy curve at saturation, are similar for the various hydrocarbons,

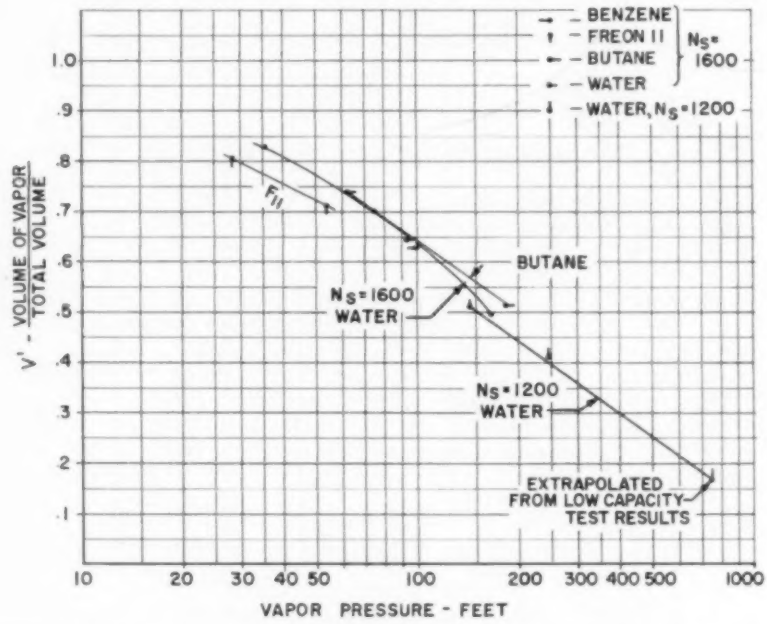

FIGURE 6—Main correlation plot showing test results for all liquids and both pumps.

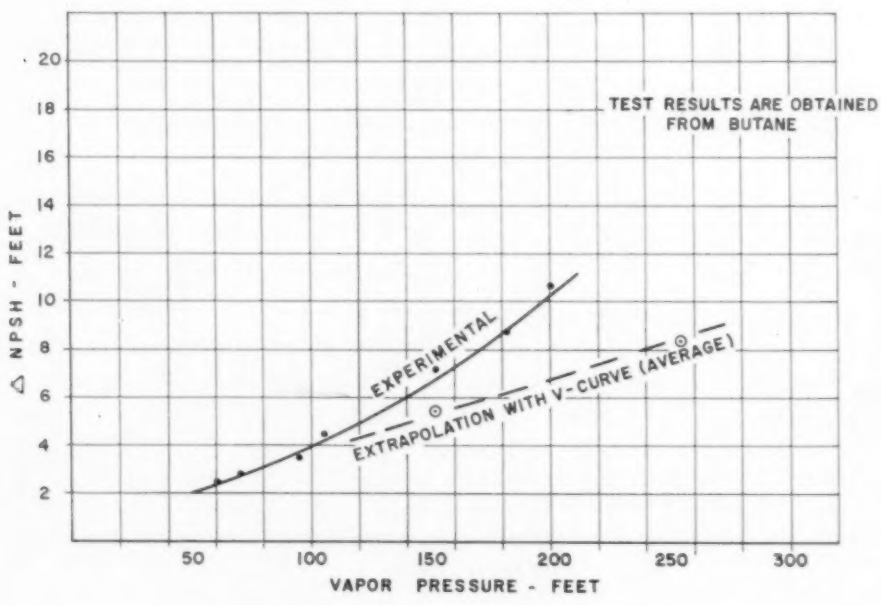

FIGURE 7—Correction for paraffin hydrocarbons.

and their latent heat of evaporation is almost constant.

This proposed correlation for hydrocarbons results in a chart with the same general trend as that published by the Standards of the Hydraulic Institute. Some arbitrary limits indicated on that chart undoubtedly represent safety or ignorance factors. Until accumulated test results on pumps of various specific speeds, suction specific speeds and operating speeds are available, some such limitations should be put on Figure 7 and Figure 8. However, the intent of this article is to present test results in graphical form, plotted against an important variable, that can be applicable for pumps similar to the pump tested and operated at the test speed. They are not intended to replace any other correction charts at this time.

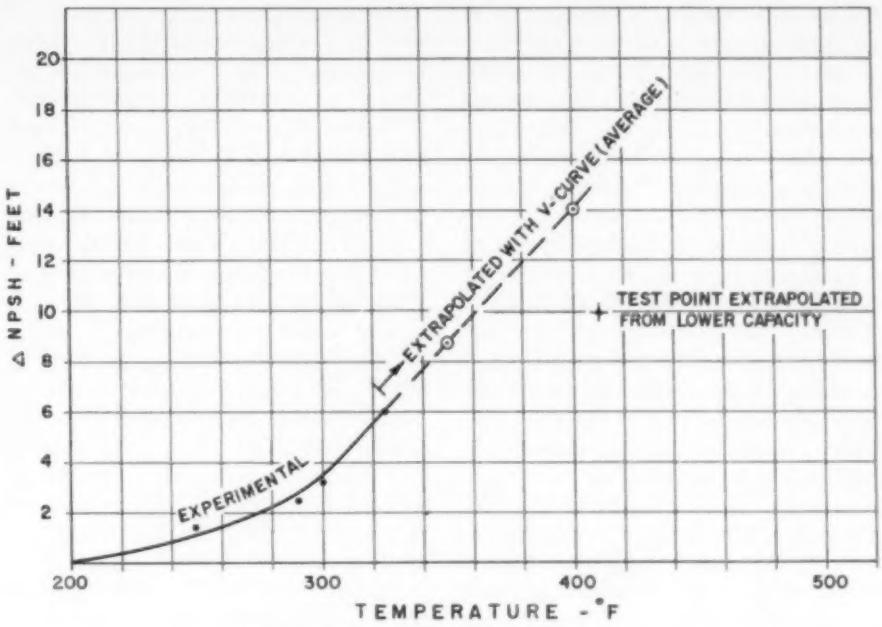

FIGURE 8—Correction for hot water.

Test Stand and Instrumentation. Because the test stand and method of testing may influence cavitation test results, a brief description of the setup is in order. In addition, we found that certain uncommon instruments were necessary or extremely useful for this type of work.

Figure 9 indicates the test stand features. Most tests were run by maintaining vapor pressure above the liquid level in the reservoir and controlling liquid level above the pump. The entire system was insulated and temperature readings were taken at various points. In most cases the NPSH could be calculated from measured suction pressure and temperature as well as independently by subtracting measured friction losses from the submergence. Note that the second method does not require a determination of vapor pressure, but assumes the vapor pressure above the liquid level in the standpipe is equal to the vapor pressure of the liquid approaching the impeller. This is true for pure liquids if the temperature is the same at both points, but is not necessarily true for liquid mixtures or liquids containing dissolved "noncondensible" gases. For such liquids, a vapor pressure determination is always necessary.

The Reid method is usually used for indicating hydrocarbon vapor pressure. It is measured at a 4:1

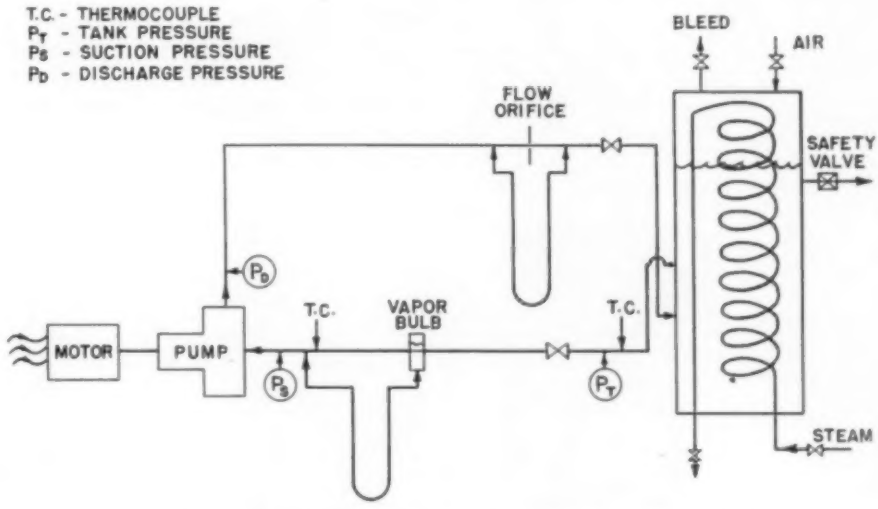

FIGURE 9—Schematic of the laboratory test stand. $N_s = 1{,}200$.

volume ratio of vapor to liquid, and at a fixed 100° F temperature. However, vapor pressure of mixtures varies with the evaporated fraction, dropping as this fraction increases. Figure 10 is a typical phase diagram for a non-electrolytic mixture of two pressures. Starting with liquid at point A, the pressure is lowered at constant temperature. Some evaporation takes place creating a vapor of composition B which occupies a certain volume. The ratio of this volume to total volume is plotted on Figure 11 for a kerosine sample. This type of vapor pressure versus volume curve may be obtained with the instrument shown on Figure 12. A Reid test would result in a point at volume ratio of 4. The "bubble point" pressure is at volume ratio 0, and is the true incipient vapor pressure.

If cavitation is to be suppressed entirely, this vapor pressure should be used for NPSH calculations. If, however, some cavitation is tolerable, vapor pressure at vapor volume ratio corresponding to that existing in the pump under cavitating conditions should be used. Working back from measured NPSH requirements, the volume ratio was between 0.4 and 2.3. For the type of kerosine tested, the difference between the bubble point pressure and the pressure at 0.5 volume ratio amounts to a reduction of required NPSH by about 8 feet, in addition to any reduction caused by

evaporative cooling (as in pure liquids). However, when the pump is supplied with NPSH calculated from the Reid vapor pressure, a value is obtained which is to 7 feet below the value required for a 3 percent performance drop. Therefore, if the pump was supplied with 16 feet NPSH using Reid vapor pressure in the calculation, it would actually have only 9 feet available. According to Figure 2 it would show a 3 percent performance loss at 200 gpm instead of at 360 gpm. Crude oils and many products containing air or light hydrocarbon gases may be expected to behave in this manner.

Another unusual device used in the test program is a direct NPSH measuring apparatus[3,1] which is placed before the suction of the pump (Figure 12). A bulb is surrounded by the pumped liquid and therefore attains the same temperature. Part of it is filled with the liquid pumped, with the balance of space taken up by its vapor. Since the temperature is the same as that of the pumped fluid, the vapor pressure is also the same. This vapor pressure is compared to the static pressure across a manometer. If the velocity head of the liquid is added to this difference, NPSH is obtained. A total pressure tube may be used instead of a static pressure tap, eliminating the necessity to measure the flow and calculate the velocity head. The method gives relatively accurate results with simple, inexpensive instrumentation at high pressures and temperatures.

For water at 400° F, an error of 1° F (¼ percent of scale reading) would result in a 6 feet error in calculated NPSH! Obviously, the accuracy of pressure measurement must be in a direct proportion to the desired accuracy of NPSH. On hot water, an error of one psi would cause an error of about 5 feet NPSH, although one psi accuracy at 400 psi pressure might otherwise be considered good and not easily exceeded.

NPSH Estimates Possible if Thermodynamic Properties Known. Even though we still cannot specify NPSH requirements for any pump operating on any liquid at any degree of cavitation to the last tenth of a foot, the correlation on Figure 6 of cavitating performance against hydrocarbon physical properties now allows us to estimate minimum required NPSH on the basis of vapor pressure. It allows a rational estimate of any liquid whose thermodynamic properties are known.

For instance, we would not expect a measurable reduction in NPSH for a liquid whose vapor pressure at pumping temperature is very low (in the order of one inch of mercury absolute), even if the liquid is a hydrocarbon. On the other hand, liquids near their critical point should allow pump operation with zero or even negative net positive suction head (or more precisely, with boiling liquid already containing some vapor). Once cavitation has begun, inducers, as used for high-speed pumps, can measurably decrease NPSH requirements only if the vapor pressure is relatively high because no liquid-vapor mixture can exist below absolute zero pressure, or in tension.

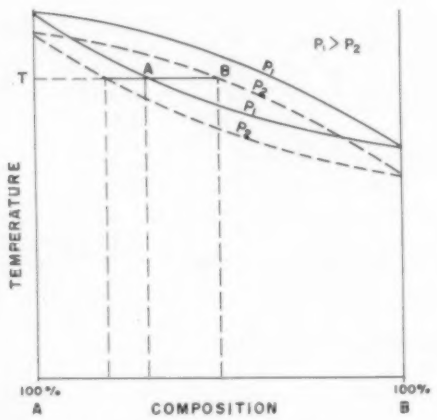

FIGURE 10—Typical phase diagram for a non-electrolytic mixture of two pressures.

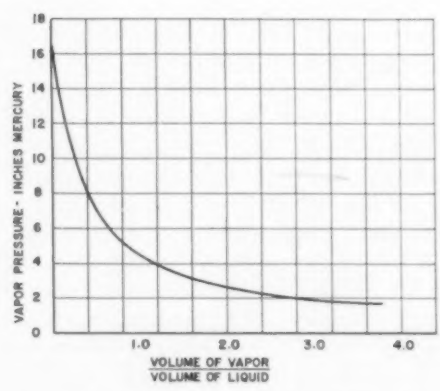

FIGURE 11—Vapor pressure of kerosine.

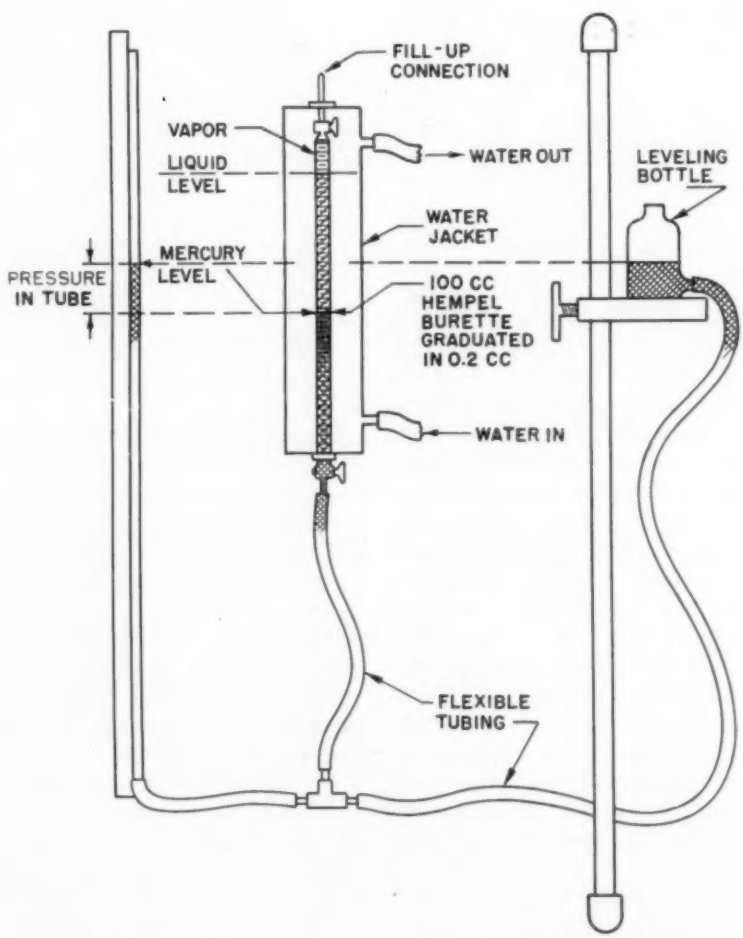

FIGURE 12—Bubble point pressure measuring apparatus used on test stand.

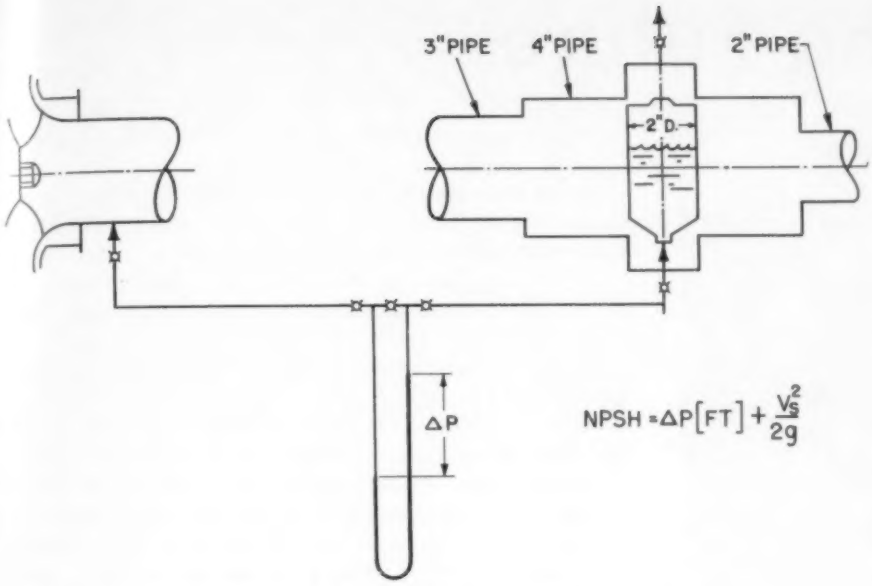

FIGURE 13—Schematic view of vapor pressure bulb.

Work already done in our laboratory sheds more light on the complex problem of vapor pressure of mixtures and solutions, in relation to cavitation and again stresses the inadequacy of any single point type of vapor pressure measurement. This knowledge is of extreme practical value, as it answers the question of what vapor pressure is applicable for pumps operating in the cavitating region. Use of the bubble pressure for the calculation of minimum non-cavitating NPSH has already been correctly suggested. The fact that vapor pressure decreases with further evaporation was also recognized as one of the reasons for reduced NPSH requirements of hydrocarbons. The contribution made by this research is mainly the derivation of the proper vapor volume ratio for the measurement or calculation of vapor pressure, for substitution into the NPSH formula for cavitating conditions.

Risks When Operating on Reduced NPSH. No study has yet been made on impeller pitting when operating with liquids at high pressures and temperatures under cavitating conditions. Other investigators have performed tests on boiling water and other liquids at atmospheric pressure using magnetostriction and other vibratory and acoustic methods.

Reports from the field on pitting with hot hydrocarbons are few and pitting does not seem to be a problem. However, the problem of pitting with water has been, and still is, being studied both in the field and laboratory. Therefore, it is fair to assume that pitting problem studies on so many other different liquids could take just as long. At the moment, the pump user takes a certain risk when he decides to apply an NPSH correction and operate the pump with limited cavitation.

When an NPSH correction is applied, the pump operates somewhere "in the break," and may run on the verge of a large performance drop. There is no safety factor. Should conditions change so that a correction factor is no longer applicable, or should the pump be required to start up the system at reduced temperature, available NPSH would certainly be insufficient and startup may be impossible. Transient conditions may impose variations in suction pressure, temperature and composition which could well result in performance loss and possible damage, if an NPSH correction was applied. Therefore, knowledge of lower minimum NPSH pump requirements on some liquids must be applied with extreme care.

Immediate and Ultimate Benefits. The recognition of the effect of variable vapor pressure of mixtures and solutions of gases, and the definition of the proper vapor pressure for cavitating and non cavitating performance can be applied immediately. Because the only NPSH correction widely known today is that for hydrocarbons, extension to other liquids enlarges the field of application. The theory offered to explain the test results points out some exceptions to the old rules which had been mainly formulated from experience. Until more test information is available, we must consider the immediate benefit limited to cost reduction for specific equipment where sufficient operating information is made available. Ultimately, this work will produce a universal method for NPSH calculation, using pump and fluid properties.

Initial equipment cost savings by NPSH correction may be small as compared to possible savings by avoiding improper selection of equipment due to nonexisting NPSH corrections or ill-defined vapor pressure data. Delays in startup and alterations can be very costly.

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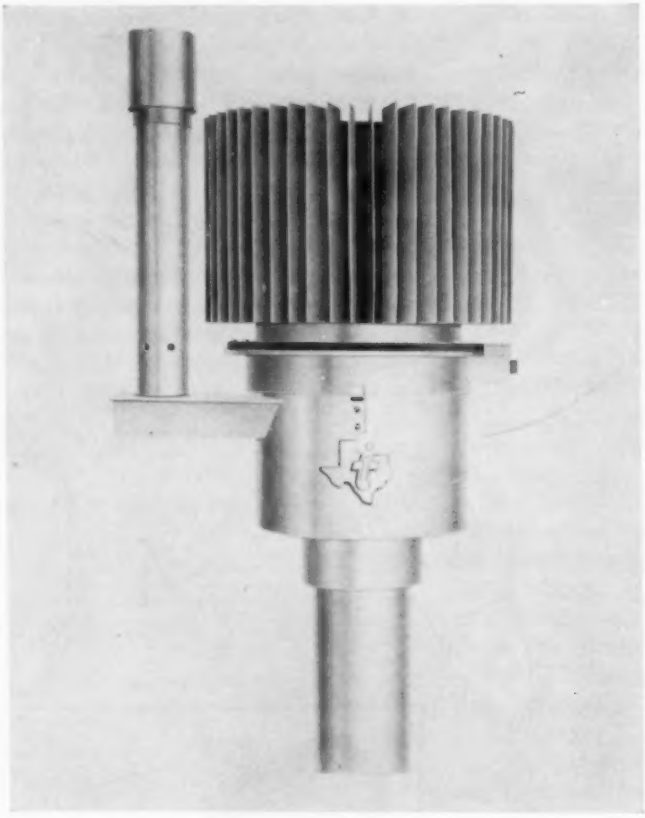
[4] "Some Corrosion Effects in Accelerated Cavitation Damage" by W. C. Leith and A. L. Thompson. ASME Paper No. 59-A-52.

About the Author

Victor Salemann attended the Technisch Hochschule in Munich Germany, and received his degree in mechanical engineering from Stevens Institute of Technology in June 1955. Upon completion of the Worthington Corporation training program he joined the Research and Development Section as a test engineer, advanced to Group Supervisor and was promoted to Research Engineer in September 1958. He is presently with Boeing Airplane Co. His work has been in fluid flow and turbomachinery. Examples are research in cavitation including hydrocarbons, pumping of gas-liquid mixtures and viscous liquids and flow of flashing fluids. He has been a co-author of a paper on flashing flow and author of the award-winning ASME paper "Cavitation and NPSH of Various Fluids." This article is based on that paper.

Ideas for the Future

By Donald M. Taylor, Engineering Editor



Thermoelectric generator burns natural gas or LPG fuel

Texas Instruments will commence marketing an 8-watt thermoelectric generator which can burn natural gas, propane or butane and is primarily designed for remote unattended field installation.

Initial applications are expected to be for the operation of valves on transmission lines or for cathodic protection of buried lines.

The new generators will rarely require maintenance or for that matter, attention. According to T. I. they are designed for rugged, long-term field use. The units weigh 65 pounds, are 12 inches wide and 17 inches high. Output is 2 volts, 4 amps. Cathodic Protection Service will handle sales and service of the units for cathodic protection application.

Refrigerated barges cut hauling cost

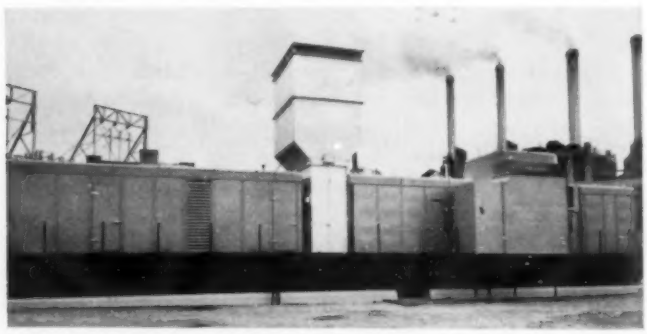
By reducing the pressure requirements of barges designed to transport anhydrous ammonia and LPG through product refrigeration, Phillips Petroleum Co. substituted low-temperature insulation for extra steel thickness and effected a sizable savings in the construction of two barges which will ply between Houston and East St. Louis, Ill. The barges are designed to transport the cargo in a fully refrigerated condition.

As far as is known, these two barges, the *Mary Lee* and the *Marjorie B.*, are the first large volume refrigerated barges ever constructed.

Each barge has two horizontal cylindrical cargo tanks 16 feet in diameter and 242 feet long. They are designed for a working pressure of 40 psig, and they were constructed of steel having good ductility at low operating temperatures.

Refrigeration equipment on the barges not only handles the heat that comes through the four inches of high efficiency insulation, it actually lowers the temperature of anhydrous ammonia from 26°F to —28°F (54 degrees F) in the six days the cargo is in transit. But the four inches of insulation is so efficient that if the refrigeration equipment were to fail during the six-day haul, the relief valves would never pop during the trip. As a matter of fact, when the temperature is reduced to —28°F, it will take two months for the ammonia to reach a temperature high enough to pop the relief valves.

The anhydrous ammonia is loaded from four 1,000-ton spheres operating at 40 psig at 26°F. At its destination, the cargo is pumped into two 15,000-ton cone roof storage tanks designed to operate at atmospheric pressure at —28°F.



Packaged gas turbine driven compressor stations are coming

Shown here is a packaged power generating plant with a gas-turbine drive rated at 13,400 horsepower. This plant which produces about 11,250 kw is one of four pre-fabricated and pre-assembled by General Electric Company for South Carolina Electric and Gas Co. All that's necessary for it to start running is to tie into a gas fuel supply, and hook in the generator to the power system.

The units are designed for remote controls, unattended operation; it is completely-self-cooled (eliminating the need for any external cooling water supply. Moreover, the units have been treated acoustically so they can operate in a suburban area.

These are major power plants, yet they can be moved in or out with little or no preparation—by truck or by rail.

Similar packaged compressor stations are being prepared for installation on one of our major gas pipe line systems! The units will be entirely self-contained—and

they can be trucked to a station site, unloaded and hooked in to the suction and discharge lines, ready for operation!

Just think!

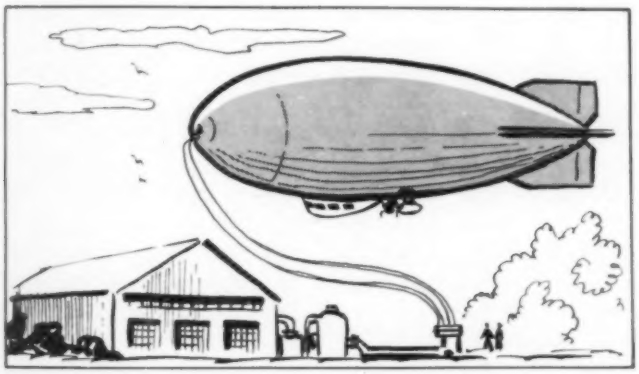
Soon the dispatcher will be calling up and saying, "Say Joe, I believe we'd better move at least one 13,000-hp station over to Caldwell County for a few days. We can get it back Saturday after next. Also, it might be a good idea to move in about 26,000 hp just downstream from the Mississippi crossing for a week or so . . . etc!"

Boy this sure makes me think. About 11 years ago, I had charge of the construction of a compressor station addition. Involved in the project was a compressor building measuring 46 ft. x 135 ft., two large cooling towers, a pump building, scrubbers, a water treating building and a water well. The five big engine-compressor units sat on top of massive concrete foundation blocks which in turn were supported by an 18-inch thick concrete mat measuring the same as the building.

About 100 men labored a good part of the summer and fall constructing this station addition, and when it was complete, most of us associated with the job felt pretty proud!

But there was only 5,000 horsepower!

This seems pretty puny today, doesn't it?



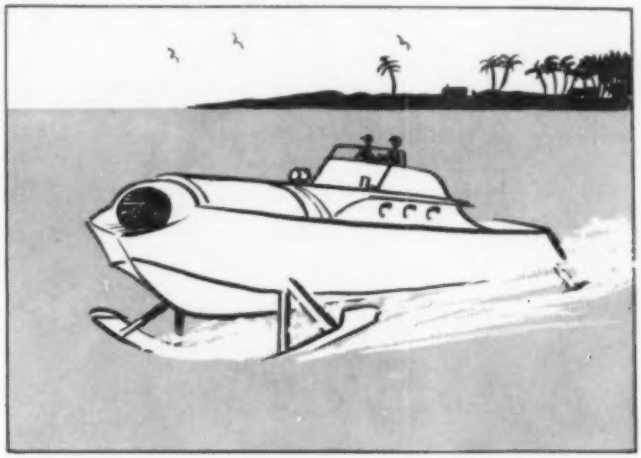
Pipe line companies will construct helium plants – for conservation

The government's helium conservation program, aimed at curtailing the annual loss of 4 billion cubic feet of the lighter-than-air gas, is moving into high gear. Since March, the U.S. Bureau of Mines has approved plans for some 22 plants which will separate helium from natural gas. Among companies receiving approval for such plants are Panhandle Eastern, Northern Natural and Cities Service.

Our total helium reserves are only 160 billion cubic feet and if the staggering losses of the past few years were allowed to grow, the gas could have been depleted by 1985. Most of the wastage occurs when natural gas containing helium is burned. The market for helium through 1985 has been estimated at 36 billion cubic feet.

New Solenoid Produces Magnetic Field

A new solenoid that can maintain a magnetic field of 88,000 gauss—(or 88,000 lines per cm^2) was developed by Bell Telephone Laboratories. This constitutes something of a breakthrough in communications and electronics; previously, solenoids could produce fields of only a few thousands gauss. The solenoid is an alloy of niobium and tin compound. Once its field is establisthed, it does not require much electrical energy to maintain it.



World's hottest jet engine will power hydrofoil boat

Our hottest jet aircraft engine will be harnessed as a hot-air generator to power a load turbine which will, in turn, drive the screws of the experimental hydrofoil boat (PLI, July 1960, page 53) now under construction. This craft is the one that skims above the waves at 60 knots, supported by underwater wing-like foils.

The jet turbine, which is being modified along lines first tried at Columbia Gulf's Clementsville station, is the General Electric J79. This unit currently powers four aircraft that fly at speeds greater than twice the speed of sound. (They are the B-58 Hustler, the F-104 Starfighter, the Vigilante and the F4H-Phantom II.) The jet will be coupled with an aft-mounted turbine which will convert the hot gases that normally supply the reactive thrust into shaft horsepower. G.E. is calling this new jet-turbine hookup the Model 240 Engine.

The high-horsepower engine will drive the 104-foot boat fast enough to enable the underwater foils to lift the hull of the craft above the water. The designer and constructor of the boat is Dynamic Developments, Inc., an affiliate of the Grumman Aircraft Corp.

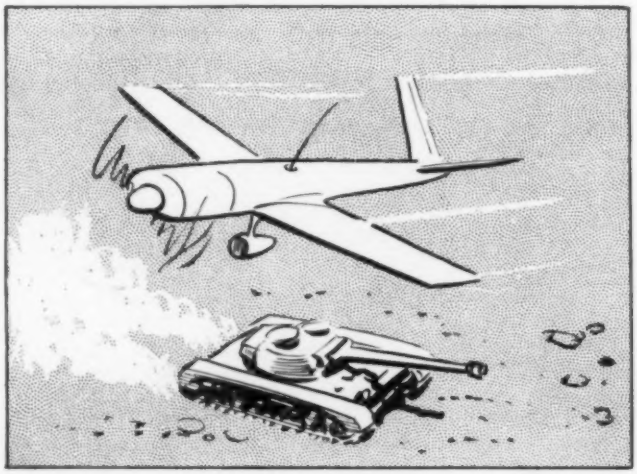
In operation, the hull will lift clear of the water at 20 knots. In shallow water, the foils will be retracted, and the vessel will operate much as other craft of similar size.

Conspicuous contrails of high-flying military aircraft will be eliminated

The conspicuous contrails of jet military planes will soon be eliminated. Armour Research Foundation, Cornell Aeronautical Laboratories and Allied Research Associates, Inc., supported by the Air Force Cambridge Research Laboratories, have come up with a solution to this problem.

The contrails are caused by the condensation of water vapor from the exhaust on nucleating particles of jet fuel combustion. Armour Research scientists have discov-

ered another substance upon which the water could condense. Then, they developed an additive using this substance to disperse the water droplets into invisible particles smaller than 0.00002 inch in diameter.



Some amazing findings of the fine particle counter

When Armour Research Foundation set out to conduct the first comprehensive study of the economic effect of air pollution in three typical midwestern towns, the first step was to develop a fine particle counter which could accurately determine the nature and extent of air pollution.

The capabilities of the instrument extended somewhat beyond the needs of the problem at hand, (which proved, incidentally, that air pollution creates hidden expenses—laundry, cleaning, office and home maintenance, to name a few) and ARF scientists found one dilly of an application for the armed forces. They found that sufficient study of the make-up of dust of a particular area made it possible to determine vehicular and troop movements in the area remotely. The instrument can be secreted behind enemy lines or else mounted in a drone airplane that flies it to take samples, and the dust count will correlate with the volume of enemy traffic.

Wonder what would happen if a pipe line spread should pass near one of the instruments. Dusty as they are in dry weather, the instrument would probably record this as a 6-million-man troop movement.

Ultrasonic waves seal plastic without heat

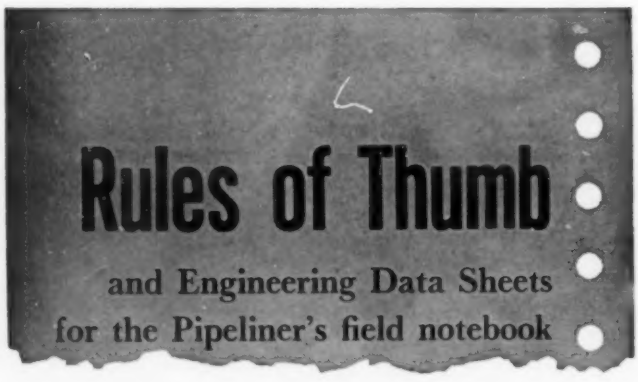
Ultrasonic waves can seal polyester plastic films without heat, and the device which produces the sound is available from International Ultrasonics, Inc., of Cranford, N. J.

The device imparts ultrasonic vibrations to overlapping sections of plastic materials, causing plastic flow and a bonding of the molecules of the two layers.

As an example of how the device is proving out, it can produce bonds between Mylar and Cronar which retain 90 to 100 percent of the original strength. This may well prove useful in coating pipe.

Miscellaneous

—45—How to Estimate the Discharge of a Pump



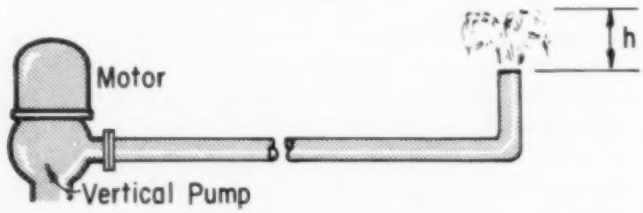
$25 for Engineering Data Sheet $15 for Rule of Thumb

These practical aids give quick, reasonably accurate answers to design, maintenance and cost estimating problems. PIPE LINE INDUSTRY will pay $25 for each chart, nomograph or data sheet published—$15 for each Rule of Thumb. Send your ideas to PIPE LINE INDUSTRY, P. O. Box 2608, Houston, Texas

Pipe the discharge of the pump some 20 to 50 diameters away from the pump and direct the piping straight up. Start the pump, and measure the fountain effect. The following formula will give you a fairly close approximation of the flow in gallons per minute.

$$GPM = 20\, d^2 \sqrt{h}$$

Where d is the inside diameter of the pipe in inches; and h is the height of the fountain in feet above the pipe opening.



Example: What is the discharge of a pump tied into six-inch outlet piping if the fountain height measures four feet?

$$GPM = 20 \times 6 \times 6 \sqrt{4}$$

$$GPM = 1440$$

In measuring the fountain height, take the very highest center line measurement.

WHAT'S HAPPENING IN PIPE LINE CONSTRUCTION

By **Donald G. DePugh,** Construction Editor

Libya's Desert Line Underway

Libya's first crude line—a 107-mile, 30-inch line from Zelten to Marsa el Brega—will be completed this year. At left, contractor Arabian Bechtel Corporation is preparing for tie-in at the only road crossing on the project. Building a road along the right of way, contractor uses a "pug" which scoops up gravel and sand, mixes it with asphalt, supplied by tank truck in background, and deposits finished product as it moves along.

Dixie Pipe Line Company Lets Contracts on 1,100-Mile LPG Line

Five contractors will begin work this month constructing the Dixie Pipe Line Company 1,100-mile, 6, 8, 10 and 12-inch liquefied petroleum gas system from Mont Belvieu, Texas, to Raleigh, N. C.

Service Pipe Line Company, who will design, engineer and supervise construction of the line, announced that Houston Contracting Company, Sharman, Allen, Gay & Taylor, Inc.; H. B. Zachry Co.; O. R. Burden Construction Corporation and Stanley-Bledsoe Corporation were successful bidders on the $35 million project.

Houston Contracting will lay 225 miles, 10-inch, from Mont Belvieu to the Mississippi River at Baton Rouge in Louisiana and Sharman, Allen, Gay & Taylor will construct 246 miles of 12-inch to Demopolis, Ala. The Demopolis-to-Griffin, Ga., 227-mile, 10-12-inch segment will be constructed by H. B. Zachry and O. R. Burden will build the Griffin-to-McBee, S. C., 270-mile, 8-inch section. Stanley-Bledsoe has the final 126-mile, 6- 8-inch portion from McBee to Raleigh.

Pipe orders have been placed, 50 percent of the right of way acquired and 45 percent of the surveying completed. Actual construction is scheduled to start on all nine spreads July 15.

The line will include 10 pump stations, whose installation will be under Service's supervision and seven distributional terminals to be handled by Phillips Petroleum Co. Initial capacity will be 50,000 barrels daily.

Eight stockholders of Dixie include Warren Petroleum Co., Phillips Petroleum, Tuloma Gas Products Co., Humble Pipe Line Co., Union Texas Natural Gas Corp., Shell Oil Co., Sinclair Pipe Line Co., and Empire Gas & Fuel Co. (Cities Service).

Stringing contractors include J. O. (Red) Willett Pipe Line Stringing Corp., Parkhill Trucking Co., and J. L. Cox & Son, Inc.

Texas Eastern Lets Contract on Major Work

Texas Eastern Transmission Corporation has awarded a contract to Houston Contracting Company for construction of 161 miles of 20-inch gas pipe lines. This is contingent on FPC approval of Texas Eastern's application.

The line would extend from West Monore, La. to Kosciusko, Miss. Texas Eastern also will lay 128 miles of 30-inch loops between Kosciusko and Lambertville, N. J. and 37 miles of laterals in New Jersey when approval is granted. The $55 million project includes 51,000 horsepower additions.

Pease Brothers Co. Awarded Gas Pipe Line

Pease Brothers Company has been awarded contract to construct the 103-mile, 20-inch gas pipe line for Mountain Fuel Supply Company and Utah Natural Gas.

The system will connect Uinta Basin to the Utah Natural main line.

Peace River Plans Crude Extension Line

Peace River Oil Pipe Line Co. Ltd. plans to lay 161 miles of 12-inch crude lines from Fox Creek station to Edmonton, Alta. This will be an extension of its Valleyview-Edson pipe line.

Utah Gas Plans 200-Mile Gas Line

Utah Gas Pipeline Corp. plans to construct a 200-mile gas line from San Arroyo and Bryson Canyon fields to Salt Lake City. The $15 million line would take gas from Sinclair Oil & Gas and Trend Oil for delivery to Kennecott Copper plant.

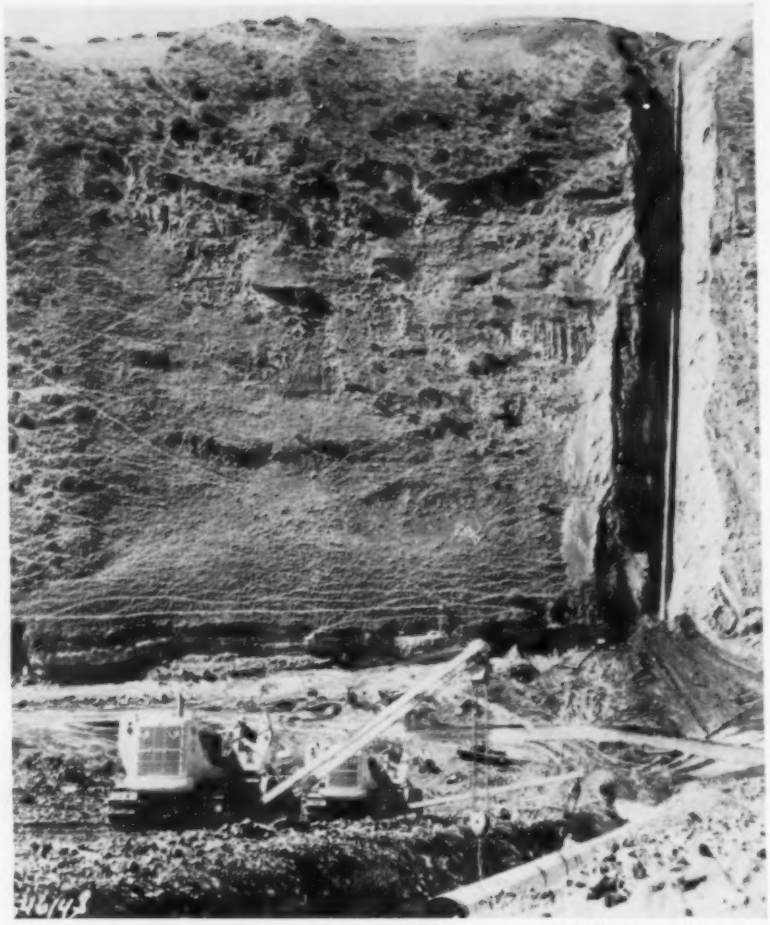


Photo courtesy Allis-Chalmers Mfg. Co.

Typical Terrain on Washington Spread

J. P. Neill & Company, Inc. finds a few obstacles in laying a 153-mile section of 36-inch main line for Pacific Gas Transmission Company. Despite the mountainous country near Pasco, Wash., Neill spread averages two miles per day.

Coastal States-Alamo Gas Plan Gas Pipe Line System

Coastal States Gas Producing Company will join Alamo Gas Supply Company in building 107 miles of 20 and 24-inch main line system to supply gas to San Antonio. Coastal also will provide a gathering system to deliver gas to the main line and will sell Alamo Gas 50 MMcf of gas daily, one-third of the initial delivery to be consumed by San Antonio.

Alamo Gas has a 20-year contract with San Antonio to deliver 2 trillion cubic feet of gas. Rio Grande Valley Gas Company and its subsidiary, Hope Production Company, will supply a minimum of 37.5 MMcf daily to Alamo Gas.

Rio will spend $1.5 million on pipe line, gathering lines and compressor facilities to move the gas from South Texas and the Rio Grande Valley. Work will begin this summer.

Coastal States will deliver gas to Alamo Gas through its Lo-Vaca gathering system which is presently under construction. Tex-Star Oil & Gas Corp. will construct a gathering system to sell and deliver gas in Live Oak county to the Lo-Vaca gathering system. Coastal will assume one-half interest in Tex-Star's facilities after initial cost and other adjustments.

Lone Star Gas Forms Subsidiary Company

Lone Star Gathering Company has been formed as a subsidiary of Lone Star Gas Company. The new company proposes to build approximately 63 miles of gathering lines of various sizes in DeWitt and Victoria counties in Texas. The system will supply gas to a purchasing pipe line company in Victoria County.

The $2½ million gathering system will have a capacity of 60 MMcf of gas daily. Construction will begin as soon as regulatory permission is granted.

The company was formed to store, gather, transport, buy and sell oil, gas, salt, brine and other mineral solutions and liquefied minerals.

It is the second wholly owned subsidiary of Lone Star to be formed since the parent firm was established in 1942. Lone Star Producing Company is the other.

Pipe Ordered for Persian Gulf Line

Pipe has been ordered for the 20-mile, 18-inch submarine crude line planned by Abu Dhabi Marine Areas Ltd. Abu Dhabi, owned by BP North America Ltd. and Compagnie Francaise des Petroles, has awarded contract to lay the line to Brown & Root, Inc.

The line will link Umm Shaif field with Das Island in the Persian Gulf. The project will include gathering system at Umm Shaif consisting of 6 and 8-inch underwater lines. On Das Island the main line will terminate at gas/oil separators. From storage tanks it will be pumped to a tanker loading berth through a 26-28-inch line, of which about half will be a submarine section to the offshore berth. Much preliminary construction work has begun on Das Island.

Commission Approves Rock Springs Project

The El Paso Natural Gas Company-Colorado Interstate Gas Company Rock Springs project received approval of the Public Utilities Commission of California. The Federal Power Commission had originally authorized the project, but will re-examine the application with new conditions put on it by the California PUC.

The state commission's conditions include delaying start of project from 1962 to 1964 and reducing price of gas from 40 cents per Mcf to 33.4 cents during 1962-63. Gas would be delivered through existing facilities these two years.

The project calls for 400 miles of 34-inch from Provo, Utah to the California border to be built by El Paso. Colorado Interstate would lay 140 miles 34-inch from Green River, Wyo. to Provo, Utah to connect with the El Paso line.

Williams Bros. Awarded Citizens Gas Contract

Citizens Gas & Coke Utility has awarded a contract to Williams Brothers Company for construction of 71 miles of 12-20-inch gas lines

between Worthington and Indianapolis, Ind. The work includes 58 miles of 20-inch; 8 miles of 16-inch and 5 miles of 12-inch.

Tennessee Gas Awards Contracts for Offshore Work

Tennessee Gas Pipeline Company has awarded a contract to Sam Carline, Inc. for construction of 8-miles of 16-inch and 7 miles of 12-inch gas lines offshore Louisiana area. The pipe will be laid in West Timbalier and Grand Isle blocks.

Pennsylvania Railroad Studies Products Systems

Plans are under study by Pennsylvania Railroad considering construction of pipe lines along the company's right of way. The lines would carry aviation fuel to Baltimore for delivery to Friendship Airport and to Washington's National Airport, Andrews Air Force Base and Dulles International Airport.

Saratoga Processing Lets Contract to Banister

Saratoga Processing Ltd. has awarded a contract to Banister Construction Co., Limited, to lay 45 miles of 16-inch and 15 miles of 4-6-inch gas pipe lines from Savanna Creek to Coleman, Alta. The line is scheduled for completion August 25.

Petrogas Processing Ltd. Laying 208 Miles of Lines

Banister Construction Co., Limited, is constructing 208 miles of 2-8-inch gas gathering system for Petrogas Processing Ltd. at Balzac, Alta. Completion date is set for October 15.

ENI Starts Work on Crude Line to Aigle

ENI is initiating work on the proposed Italy-Switzerland crude line running from Genoa to Aigle. The Italian firm is also building a system in Italy connecting Genoa, Milan, Cremona, Torino. This will expand to Aigle and ENI plans to extend it further to Germany.

Teton Pipe Line Corp. Completes Crude System

Teton Pipe Line Corporation has completed its Dead Horse Creek-Barber Creek to Sussex crude oil transmission and gathering system. The system consists of 68 miles of 6-inch main line and 3-4-inch gathering lines connecting oil fields in the western portion of Wyoming's Powder River Basin with Service Pipe Line Company's system at Sussex.

Photo courtesy Allis-Chalmers Mfg. Co.

Canada-California Gas Line

Pacific Gas Transmission Company's 614-mile, 36-inch gas line runs through Idaho, Washington and Oregon as the middle section of the Northern Alberta-San Francisco 1,400-mile, $400 million system. J. P. Neill crews begin lowering-in operations on Washington spread.

Suwanee Pipe Line Company Formed To Construct Products Pipe Line

A major products pipe line from Baton Rouge, La., to Greenville, N. C., is under consideration by several major producers. The line would extend nearly 800 miles and would be 22 inches in diameter.

Companies involved in the new pipe line proposal include Texaco Inc., Gulf Refining Company, American Oil Company, Cities Service Co., Continental Oil Company, The Pure Oil Company and Sinclair Oil Corporation. Sinclair would operate the line and plans to establish headquarters in Atlanta, Ga.

Several of the firms have affiliated products lines from Baytown and Port Arthur, Texas, to Baton Rouge. The Suwanee Pipe Line Co. line would give them a system from Houston area to North Carolina.

The line would compete with Plantation Pipe Line Co. which extends from Baton Rouge to Greenville. Several of the Suwanee owners ship through Plantation, a common carrier.

Humble Lets Contract To Grayco Constructors

Humble Oil & Refining Company has awarded a contract to Grayco Constructors for construction of 13 miles of 26-inch gas line in Texas from Port Acres to Bridge City.

Arabian Oil Company Lets Coating Contract

Contracting and Trading Company has been awarded a contract to coat approximately 45 miles of 12, 14, 16, 26, and 30-inch pipe for Arabian Oil Company. Coating will include coal tar enamel and concrete.

Trunkline Gas Lets Contracts to Sam Carline

Trunkline Gas Company has let a contract to Sam Carline, Inc., for construction of 35 miles of 20-inch gas line near Cow Island in Louisiana.

Transco Lets Contracts On 219 Miles of Loops

Transcontinental Gas Pipe Line Corporation has let contract to three contractors on 219 miles of 30-36-inch loop lines in Texas, Louisiana, Mississippi, Alabama, South Carolina and North Carolina.

Houston Contracting Company will lay 60 miles of 30 and 36-inch loops in Texas and Louisiana. C. S. LeNoir Construction Company has 84 miles of 36-inch in Mississippi and Louisiana and Williams Brothers is constructing 75 miles of 36-inch in Georgia, North Carolina and South Carolina.

PROPOSED PIPE LINE CONSTRUCTION

Here in convenient summary form is Pipe Line Industry's listing of company, line size, length, service, location and project status.

* indicates that this item is a new entry or that status of this project has changed since last appearance.

U.S.

Anadarko Production Co., 83 miles, 12-inch, gas, Spivey-Grabs-Basil field to El Dorado, Kan., planned.

Algonquin Gas Transmission Co., Boston, 25 miles, 20-inch; 8 miles, 8-inch, gas, and 12,000 hp addition in Massachusetts, $6 million, FPC Authorization.

Ashland Oil & Refining Co., Ashland, Ky., 24 miles, 6-inch, crude, Blaine to Catlettsburg, Ky., planned.

Border Gas Transmission Company, 300 to 400 miles, gas, gathering, in South Texas, $10 million, planned.

Buckeye Pipe Line Co., New York, 42 miles, 8-inch, products, Flint to Bay City, Mich., $1.7 million, planned.

California Gas Transmission Company, Los Angeles, (subsidiary of Tennessee Gas Transmission Company), 292 miles, 20-34-inch gas, from Mexico-California border near Mexicali, to Los Angeles and 10,000 hp. to tie into Texas Mexico-California line, $50 million, before FPC and California Public Utilities Commission.

Carolina Pipeline Co., 87 miles, 8-10-inch, gas, Aiken to Camden, S. C., contract let to **Panama-Williams Corp.**

Coastal Transmission Corp., Houston, 71 miles, 3 to 10-inch, gas, laterals; 5,500 hp in stations at Port Lavaca, Texas, and Eunice, La., and additional 1,500 hp at Robstown, Texas, $7.2 million, FPC examiner authorization.

Colorado Gas Transmission Co., 250 miles, 20-inch, gas, Southwest Colo., to Colorado Springs, before Colorado PUC.

Colorado Interstate Gas Co., Colorado Springs, 140 miles, 34-inch, gas, Green River, Wyo.,-to-Provo, Utah; 109 miles, 26-inch, Texas Panhandle to southeastern Colorado, 136 miles, 34-inch, southeastern Colorado-to-Pueblo, Colo.; 107 miles, 30-inch, Pueblo-to-Denver, $91 million, FPC conditional authorization.

Colorado Oil & Gas Corp., Denver, 400-miles, gas, from Gubik field to Fairbanks, Alaska, planned.

Columbia Gulf Transmission Company, Houston, 97 miles, 30-inch, loops in Kentucky, Tennessee, Mississippi and Louisiana; 29 miles, 12-inch lateral in Louisiana, $15 million, before FPC.

Continental Pipe Line Co., Ponca City, Okla., 62 miles, 3-6-inch, crude, gathering system in Oklahoma, contract let to **P & A Construction Co.**

* **Dixie Pipe Line Company**, Tulsa, 1,100 miles, 6-12-inch, LPG, Mont Belvieu, Texas to Raleigh, N. C., $35 million, contracts let to **Houston Contracting Company, Sharman, Allen, Gay & Taylor, H. B. Zachry, O. R. Burden Construction Corp.**, and **Stanley-Bledsoe Corp.**

El Paso Gas Supply Company, El Paso, Texas, 228 miles, 30-inch, gas, main, Live Oak to Sutton County, Texas, $30 million, before FPC.

El Paso Natural Gas Company, El Paso, 199 miles, 30-inch, Permian-San Juan crossover loop, before FPC.

17 miles, from Pacific Gas Transmission Co. facilities to near Spokane, Wash., before FPC.

34 miles, 20-inch, Puckett to Goldsmith, before FPC.

23 miles, 20-inch, Goldsmith to Eunice-Plains line, before FPC.

9 miles, 20-inch, Goldsmith-Plains loop, before FPC.

43,600 hp in new and existing stations in Texas, Oklahoma, New Mexico and Utah, before FPC.

400 miles, 34-inch, Salt Lake City, Utah, to California border, FPC conditional authorization.

35 miles, 8-inch, gas, to deliver gas to Southern Union Gas Company in Dallas, $1 million, before FPC.

Equitable Gas Company, Pittsburgh, Pa., 31 miles, 16-inch, and 26 miles, 20-inch, in West Virginia and Pennsylvania, $5 million, before FPC.

Great Northern Pipe Line Co., 64 miles, crude, extension to Lignite field, North Dakota, planned.

Houston Texas Gas & Oil Corp., St. Petersburg, Fla., 235 miles, 2 to 6-inch, gas, laterals; 20,000 hp in five new stations; $16 million, FPC examiner authorization.

Kansas-Nebraska Natural Gas Company, Hastings, Neb., 165 miles, 2-8-inch, gas, extension from Alliance, Neb., to Chadron, Crawford, Hemingford, Hay Springs, Gordon and Rushville, Neb., before FPC.

45 miles, 2-3-inch, gas, in Kansas, approved by Kansas Corporation Commission.

2,000 hp addition at Scott City, Kan., FPC approval authorization.

2,500 hp addition at Holcomb, Kan., before FPC.

Lone Star Gas Company, Dallas, 47 miles, gathering lines in Palo Pinto, Erath and Stephens counties, Texas, planned.

* **Lone Star Gathering Company**, Dallas, 63 miles, gas, gathering, in DeWitt and Victoria counties, Texas, $2½ million, planned.

Long Island Pipeline Company, New York, 75 miles, 20-inch, products, Linden, N. J., to Long Island, N. Y., $30 million, planned.

Lo-Vaca Gathering Co., (Coastal States Gas Producing Co.) 230 miles, 6-20-inch, gas, gathering, Live Oak to Lavaca County, Texas, planned.

Matador Pipe Line Corp., Denver, 175 miles, crude, from Bottineau, Burke and Renville counties, N. D., to Cromer, Man., Canada, $4 million, proposed.

Michigan Wisconsin Pipe Line Company, Detroit, 88 miles, gas, 3,000 hp, take gas from Northern Natural at Janesville, Wis., before FPC.

Mid-America Pipe Line Co., 405 miles, 10-inch, LPG, Superior, Wis., to Chicago, $12 million, considered.

106 miles, 6-inch, LPG, extension from Whiting to Ogden, Iowa, planned for 1961.

100 miles, LPG, extension from Ogden City, to Charles City, Iowa, planned for 1962.

Monterey Gas Transmission Company, Houston, 216 miles, 30-inch, gas, Clear Lake, Texas, to Alexandria, La., planned.

* **Mountain Fuel Supply Co.**, Salt Lake City, 103-mile, 20-inch, gas Uintah Basin to Clear Creek, Carbon County, Utah, contract let to **Pease Brothers Co.**

Natural Gas Pipeline Company, Chicago, 285 miles, 30-inch; 60 miles, 36-inch and 22 miles, 8-inch, gas, and 64,200 hp, in Illinois, Texas, Arkansas, Kansas, Nebraska, Iowa and Missouri, $52 million, before FPC.

New Haven Pipeline, Inc., products line, New Haven, Conn. to Springfield, Mass., $2.5 million, planned.

Niagara Mohawk Power Corp., 122 miles, 12-inch, Watertown and Massena, N. Y., contract let to Fulghum Contracting Corporation pending FPC approval.

Northern Natural Gas Company, Omaha, 50 miles, gas line, 2,000 hp, before FPC.

99 miles, gas, 4,660 hp, $8.9 million, before FPC.

233 miles, gas, 14,000 hp, to connect to Michigan Wisconsin system at Janesville, Wis., $23 million, contracts let to **R. H. Fulton** and **Panama, Inc.**

Northern Gas Products Co., (subsidiary of Northern Natural Gas Co.), 350 miles, 8-inch, LPG, Bushton, Kan., to Des Moines, Iowa, $12 million, planned.

Northwestern Refining Co., crude gathering system, Rival and Lignite fields, North Dakota, $625,000, Public Service Commission approval.

Ohio Fuel Gas Co., 59 miles, gas, 4-24-inch main lines, in Belmont, Carroll, Cuyahoga, Fairfield, Logan, Lorain,

Marion, Muskingum, Stark and Wayne counties, Ohio, $5.1 million, planned.

Oklahoma Illinois Gas Pipeline Co., (Fish Engineering and Pan American Petroleum Corp.) 550 miles, gas, Woodward, Okla., to St. Louis, planned.

Pacific Gas & Electric Co., San Francisco, 120 miles, 30-inch gas loops, Topock to Milpitas, before FPC.

Panhandle Eastern Pipe Line Co., Kansas City, 305 miles, 30-inch, 40 miles, 26-inch, gas, loops, and 43,000 hp, and gathering facilities, $60 million, before FPC.

200 miles, 22-24-inch, gas, lateral, from Elk City, Okla., to Haven, Kan., $15. million, before FPC.

* **Pennsylvania Railroad**, products pipe lines along railroad's right of way to serve Friendship Airport in Baltimore and Washington's National Airport, Andrews Air Force Base, and Dulles International Airport, considered.

Phillips Pipe Line Co., Bartlesville, Okla., 75 miles, main line, 85 miles, gathering crude, from Camrick field, Gray, Okla., to Phillips, Texas, planned.

Southern California and Southern Counties Gas Cos., Los Angeles, 93 miles, 34-inch, California-Nevada border to Newberry, Calif.

St. Lawrence Gas Company, Inc., Ogdensburg, N. Y., 75 miles, gas, main, United States-Canadian border to Ogdensburg, N. Y., $3.4 million, FPC approval.

SunOlin Chemical Company, Philadelphia, 6,000 feet, ethylene line, under Delaware River, Claymont, Penn., to Penns Grove, N. J., $2 million, planned.

* **Suwanee Pipe Line Co.**, (Sinclair Oil Corp.) Atlanta, 800 miles, 22-inch, products, Baton Rouge to Greenville, N. C., planned.

Tennessee California Gas Transmission Company, (subsidiary of Tennessee Gas Transmission Co.), 100 miles, 26-inch, gas, gas fields in South Texas to Texas-Mexico border near Reynosa, before FPC.

Tennessee Gas Pipeline Co., Houston 167 miles, 30 and 36-inch loops in Ohio and Pennsylvania, and 36,800 hp in 4 new and 3 existing stations, $38 million, before FPC.

18,300 hp in 3 new stations, $6 million, before FPC.

50 miles, 26-inch loop in Kentucky, FPC authorization.

21 miles, 16-inch, 2 miles, 12-inch, gas, offshore Louisiana, Vermilion blocks 46 and 64, $2.3 million, before FPC.

84 miles, 10-20-inch, gas, offshore Louisiana, FPC authorization.

Texas Eastern Transmission Corp., Shreveport, La.

66 miles, 30-inch, gas, loops, between Vidor, Texas, and Lambertville, N. J., and 33,710 hp in four existing stations, $17.5 million, temporary FPC authorization.

165 miles, 20-inch, gas, West Monroe, La., to Kosciusko, Miss.; 128 miles, 30-inch, loops, between Kosciusko and Lambertville, N. J., and 37 miles, laterals in New Jersey, 51,000 hp., $55.2 million, before FPC.

144 miles, gas, 46,300 hp. $27.8 million, for 1962, before FPC.

Texas Eastman Co., Longview, Texas, 280 miles, 6-inch, products, Houston to Longview, planned.

Texas Gas Transmission Corp., Owensboro, Ky., 96 miles, 26-30-inch, gas loops, Louisiana, Arkansas, Mississippi, Tennessee, Kentucky and Indiana; 50 miles, 8 and 16-inch extension into Terrebonne, La., producing area, $16.8 million, before FPC.

Transcontinental Gas Pipe Line Corporation, Houston.

211 miles, 36-inch, and 30-inch, loops and additional 32,040 hp, in Texas, Louisiana, Mississippi, Alabama, Georgia and South Carolina, $52 million, contracts let to Houston Contracting Co., Williams Bros. Co., and C. S. LeNoir Construction Co.

163 miles, 36-inch, gas, loops, in Louisiana, Alabama, Mississippi, Georgia, North and South Carolina, Virginia, Maryland and Pennsylvania, 10,500 hp, $30 million, before FPC.

13 miles, 24-inch and 18 miles, 20-inch loops, Louisiana, FPC authorization. 14 miles, 16-inch laterals, 1-mile, 12-inch lateral, Louisiana, $2.1 million, FPC authorization.

29 miles, 20-inch, gas, and 2,500 hp, in South Texas to take gas from South Texas Natural Gas Gathering Co., $2.4 million, FPC authorization.

Trans-Southern Pipeline Corp., Houston, 1,080 miles, 12-inch, LPG, from Mont Belvieu, Texas, to Danville, Va., and 215-mile spur line from Atlanta to Georgia-Florida border, $63 million, planned.

Trunkline Gas Company, Houston, 97 miles, 30-inch, loops, between Longville, La., and Tuscola, Ill., 27 miles, supply laterals, and two 6,000 horsepower compressor stations, before FPC.

* 74 miles, 26-inch, gas, Longville to Cow Island, La., 24 miles, 18-inch, Cow Island to Gulf shore, and 24,000 horsepower, $18 million, FPC Authorization.

United Gas Pipe Line Co., Shreveport, La., 59 miles, 36-inch, gas, lateral, between Bastian Bay and Plaquemines Parish, La., $17 million, temporary FPC authorization.

217 miles, 30-inch, Lafayette to Monroe, La., $32 million, temporary FPC authorization.

* **Utah Gas Pipeline Corp.**, 200 miles, gas, San Arroya and Bryson Canyon fields to Salt Lake City, $15 million, planned.

Valley Gas Transmission, Inc., Houston, 55 miles, 3 to 8-inch, gas, gathering, in Hidalgo, Brooks, Starr and Jim Wells counties, Texas, $15 million, before FPC.

International

ACT Oils, Ltd., Montreal, 400 miles, crude, Dawson Creek, B. C., to Bella Coola, B. C., before B. C. Government.

Ajax Alberta Pipeline Ltd., 28 miles, 10-inch, gas, main, Morinville to Westlock, Alta., planned.

Assistencia de Oleodutos du Petrobras, Rio de Janeiro, 280 miles, 12-inch, crude, Rio de Janeiro to Belo Horizonte, Brazil, planned.

* **Abu Dhabi Marine Areas Ltd.** (British Petroleum Co. and Compagnie Francaise des Petroles) 20 miles, 18-inch, crude, from Umm Shaif offshore field to Das Island, Persian Gulf, contract let to **Brown & Root Inc.**

* **Alberta Gas Products System, Ltd.**, 725 miles, 8-12-inch, gas liquid gathering system, to connect with Trans Mountain system for delivery to U.S. border, before Alberta Conservation Board.

Barnabos Group (Italian Interests), crude line from Venice, Italy, to Insbruck, Austria, with extension to Munich, Germany, planned.

Bituminous Oil Pipeline Co., Calgary, 250 miles, crude, from Athabasca tar sand plant in northeastern Alberta to Edmonton, approved.

British American Oil Co., Ltd., Toronto, 125 miles, gas, Pincher Creek fields to Calgary, Alta., before Alberta Public Utilities Board.

* **British Columbia Oil Transmission Co.**, 75 miles, crude, Blueberry field to Taylor, B.C., $8 million, planned.

Burmah Oil Co., Ltd., 850 miles, crude, 20 inch, from Nahorkatiya to Calcutta, India. Contract let on 250 miles to Mannesmann-Saipem.

Cartier Gas Corp. (St. Maurice Gas, Inc., and Consumers Gas Co., Toronto), 170 miles, gas, Montreal to Quebec City, planned.

Consolidated Gathering Systems, Ltd., Calgary, 198 miles, crude, Sturgeon field to Edmonton, planned.

Foothills Pipe Lines Ltd., 1,300 miles, LPG, from Alberta-Saskatchewan border to Chicago, tie-in with Westalta Products Pipeline proposed system in Alberta, $100 million, before Alberta Board of Public Utilities Commissioners.

Gas del Estado, Buenos Aires, 1,050 miles, 30-inch, gas, Comodoro Rivadavia field to Buenos Aires, $380 million, bids submitted for design and construction by Texas Eastern Transmission Corp., ENI, and an Argentine firm.

Gas Trunk Line of British Columbia, Vancouver, 250 miles, 30-inch, gas, main, Fort Nelson to Taylor, B. C., planned.

Gasversorgung Sueddeutschland, 180 miles, gas, Mannheim to Karlsruhe to Kehl and Ulm, $20 million, planned.

* **Hudson's Bay Oil & Gas Co. Ltd.**, Calgary, 41 miles, 4-8-inch, condensate, Waterton-Castle River area and Pincher Creek field to Carway to connect with Galcier system, planned.

Hughenden Pipeline, 125 miles, products, Dick Lake gasoline plant to Hughenden Region, Alta., planned.

Hydrocarbons Pipeline, Ltd., Winnipeg, Manitoba, 500 miles, 4-12-inch, products, gathering system to Calgary and Interprovincial system, planned.

Independent Pipe Line Co., 2,019 miles, 34-36-inch, crude, Edmonton to Montreal, 23,000 pump horsepower, $395 million, before Borden Commission.

International Gas Co., Los Angeles, 1,800-miles, 30-inch, gas, Reynosa to Mexicali at California border, considered.

Interprovincial Pipe Line Company, 350-mile extension from Toronto to Montreal, looping line from Edmonton to Toronto, crude, $240 million, considered, products pipe line, Superior, Wis., to Chicago, considered.

90-mile, crude, Hamilton, Ont., to Buffalo, N. Y., before National Energy Board of Canada.

Mid-Continent Pipe Lines, Ltd., 1500-mile, 30-inch crude, Edmonton to Chicago, planned.

Naphtha Israel Oil Co., 75 miles, 6-inch, gas, Rosh-Zohar field to Ashdod Yam on Mediterranean planned.

National Iranian Oil Co., 146 miles, 6 inch, crude, from Azna to Isfahan, Iran, $5 million, planned.

Northern Alberta Pipe Lines, Ltd., Edmonton, Alta., 110 miles, 10-inch, gas, main, Lac La Biche to Edmonton, $3 million, planned.

Northern Pipe Line Company, 153 miles, 16-inch, crude, from Regina, Saskatchewan, to Clearbrook, Minn., $10 million, planned.

* **Peace River Oil Pipe Line Co., Ltd.**, 161 miles, 12-inch, crude, main line, Fox Creek to Edmonton, Alberta, planned.

Petroleos Mexicanos, 4, 6 and 8-inch, products, Mexico City-Puebla to Cuernavaca, planned.

1,240 miles, 34-inch, gas, Reynosa to Mexicali, Mexico, $160 million, negotiating with Tennessee Gas Pipeline Company for design and construction of the line.

360 mile, 12-inch, products, Minatitlan to Puebla and Mexico City, planned.

Products, Guadalajara to Tepic, planned.

Products, Aguascalientes to Zacatecas, planned.

6-inch, products, Guaymas to Ciudad Obregon, considered.

8-inch products, Guaymas to Hermosillo, considered.

Gas, Ciudad Carmen to Ciudad Pemex.

8-inch, crude Comalcalco to Minatitlan.

Crude, Minatitlan to Salina Cruz, contingent on proposed refinery on Pacific Coast.

149 miles, 10-inch, products, Ciudad Pemex to Minatitlan, planned.

181 miles, 4-inch, products, Mexico City to Salamanca, planned.

Pipelines of Puerto Rico, Inc., 95 miles, 8-inch, products, Penuelas to San Juan, Puerto Rico, approved.

Provincial Pipe Lines, Ltd., 700 miles, 3-16-inch, hydrocarbon line gathering system in Alberta, $25 million, before Alberta Oil and Gas Conservation Board.

Quebec Gas Transmission Lines, Inc., Montreal, 300 miles, gas, main, Quebec to Montreal, planned.

Rangeland Pipe Line Company Limited, 111 miles, 8-inch, crude, southeastern Alberta to Calgary, $3 million, planned.

Saskatchewan Power Corp., 179 miles, 4-6-8-inch, gas, planned.

Societa Nazionale Metanodotti, 650 miles, 18-inch, crude, Genoa to Milan-Cremona-Torino, Italy, and Aigle, Switzerland, with extension to Karlsruhe and Munich, Germany, contract let on Italian portion to **Saipem.**

Societe du Pipe Line Sud-European, Paris, 432 miles, 34-inch, crude, port of Lavera to Strasbourg, with lateral extending 40 miles to Karlsruhe, Germany, approved by French cabinet.

Soc. Siciliana Metanadotti, gas line from Hassi R'Mel field in Algeria through Tunisia, across Mediterranean to Sicily and into Italy, considered.

Soc. Trapil, 200 miles, 12-inch, crude, La Havre to Paris, France, planned.

Standard-Vacuum Oil Company, 60 miles, 8-inch, gas, main, in South Sumatra, considered.

Ste. d-Etudes de Pipeline Intercontinetaux, Paris, 1,400 miles, 30-40-inch, gas, from Hassi R'Mel field in central Algeria across Mediterranean, through Spain, France and into West Germany, considered, Fish International Corporation making engineering and feasibility studies.

Sui Gas Transmission Co., Multan, Punjab, India, 145 miles, 8-inch, gas, from Sylhet to Dacca, East Pakistan, $9 million, considered.

130 miles, 16-inch, gas, main line, Multan to Lyallpur, planned.

Syrian Pipeline, Damascus, 500 miles, crude, from Karshuk field, Syria, to Mediterranean, planned.

300 miles, products, from Homs to tank farms in Damascus, Aleppo and Latakia, planned.

Trunk Pipelines Ltd., London, 70 miles, products, Canvey Island to Denham, Buckinghamshire, bill before Parliament. Extension of line from Denham to Birmingham, planned.

Westalta Products Pipeline Ltd., 900 miles, LPG, from Northern Alberta to Saskatchewan border, to deliver hydrocarbons to Foothills Pipe Lines, $40 million, before Alberta Board of Public Utilities Commissioners.

Williams-McWilliams Industries, Inc., New York, 441 miles, 6-inch, crude, Villa Montes, Bolivia, to Villa Hayes, Paraguay, considered.

Panama, Inc., Awarded Work by United, Humble

Humble Oil & Refining Company has let contract to Panama, Inc., for construction of 9 miles of 26-inch in Louisiana. United Gas Pipe Line Company awarded the crossing of the Amite River in Louisiana to Panama, Inc.

ON THE LINE

Purged Cavern

At Sun Oil Company's Marcus Hook, Pa. refinery, an underground cavern was purged with CO_2 to displace air for propane storage. Workmen are shown preparing cavern before purging. All equipment used in cavern was lowered through a 42-inch shaft and assembled in the cavern. Average height of L-shaped storage area is 40-feet; cavern roof is 380-feet below ground surface. Using 112 tons of carbon dioxide the 2.2 MMcf capacity cave was purged in 20 hours. It will hold 400,000 barrels of propane.

Water Plant Contract

Stearns-Roger Mfg. Co. of Denver has been awarded the contract to operate and manage the saline water demonstration plant at Freeport, Texas, by the Interior Department's Office of Saline Water.

Firms interested in operating and managing the plants at San Diego and Webster, S. D. have until August 1 to apply to the department.

Education Grants

Standard Oil Foundation, Inc., a non profit organization financed by Standard of Indiana, announced a grant of $175,000 for education to be shared by 160 privately financed liberal arts colleges. These colleges total an enrollment of 140,000 students in 13 Midwest states.

Since 1952 the foundation has granted $1.5 million to independent colleges. No restrictions are placed on the use of the funds by a college as long as they are spent wherever they are needed to improve educational program.

Contracts Awarded on West Shore Pipe Line

West Shore Pipe Line Company awarded contracts on its 285-mile, 10- 16-inch products pipe line to five contractors. Midwestern Contractors, Inc.; Contracting and Material Company; Houston Contracting Company; Somerville Construction Company; and Panama-Williams Corporation will lay the line extending from Chicago to Green Bay, Wis.

Midwestern was awarded 10 miles, 16-inch near Hammond, Ind. Contracting and Material has sections two and three consisting of 36 miles, 16-inch, in Cook and Will counties, Ill., and 33 miles, 16-inch in Cook and Du Page counties, Ill., extending to Des Plaines terminal.

Houston Contracting will construct section four which includes 61 miles of 16-inch from Des Plaines to St. Martins Junction near Milwaukee. Somerville has sections five and seven. This includes 43 miles, 16-inch, in Milwaukee and Waukesha Counties, Wis., extending from St. Martins to Jones Island and Granville station. Also Somerville will lay 29 miles 10-inch in the vicinity of Green Bay.

Panama-Williams will construct section six—a 76-mile, 10-inch segment from Granville station site in Milwaukee County to the Brown County line.

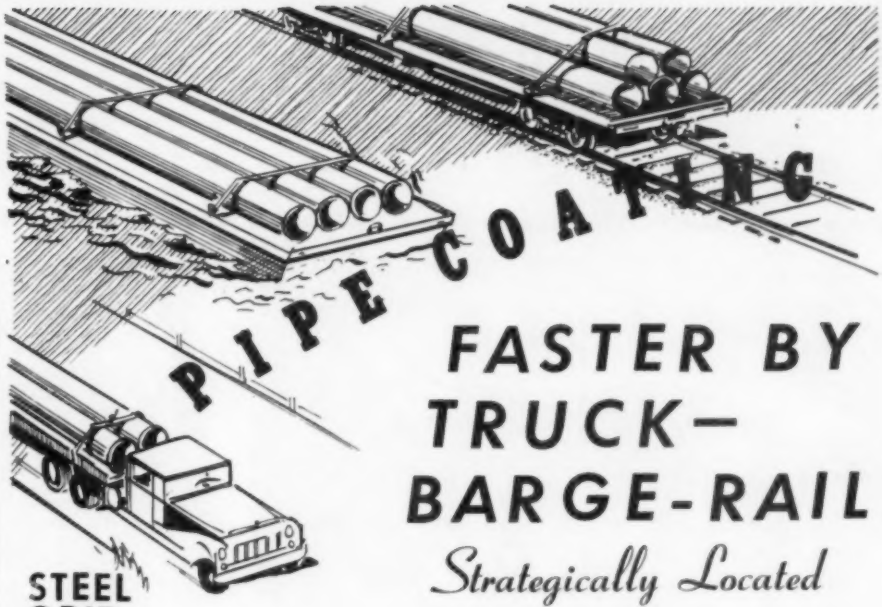
Contracts for stations and attendant connections to shippers' tank farms and terminals will be awarded in July. Completion of the line is expected in September and stations in November.

Sinclair Pipe Line Co. Lets Contract to Fulton

R. H. Fulton & Company has been awarded a contract by Sinclair Pipe Line Company for construction of 170 miles of 8-inch line. The line will extend from LaVerne, Okla. to near Newalla, Okla.

Grayco Awarded Trunkline Work

Grayco Constructors, Inc. has been awarded a contract by Trunkline Gas Company to lay 22 miles of 18 and 20-inch gas lines from near Delcambre, La. to near Cow Island, La.



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How to do it

PIPE LINE HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, PIPE LINE INDUSTRY, P. O. Box 2608, Houston 1, Texas

Milk Can Helps Supply Sufficient Fuel to Engine

There's a practical solution to the problem of supplying sufficient fuel for an all-night run to an engine-driven pump used for de-watering an isolated area. This will avoid sending a man back at intervals to replenish the fuel supply.

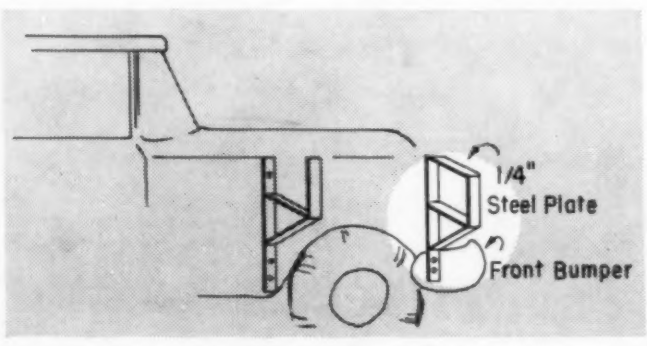
Disconnect the fuel line from the fuel tank to the engine and replace it with a rubber hose to an old milk can. Comes time to move the rig, replacing the original line only takes minutes.

By regulating the amount of fuel in the can, the pump can be run for any desired interval, automatically shutting down when fuel supply is exhausted.

Attach Case to Door To Hold Clipboard, etc.

Next time you bring your truck to an abrupt stop and your clipboard falls off the seat onto the floor along with your notebook, smokes and PLI magazine, don't cuss, instead . . .

Take a very light gage sheet metal box and attach it to the inside of the truck door on the driver's side (photo). Now you have a case to hold such items as clipboard, notebook, etc. Dimensions are 13 inches long, 2 inches deep and 10 inches high. This tin case is especially good for the metermen. And then you're ready for that next abrupt stop.



Prevent Pipe in Rack From Doing Damage in Quick Stop

A pipe rack on the side of a pickup or bob-tail truck is handy, yet dangerous in a way. A sudden stop or an otherwise minor wreck can launch the pipe like arrows from a bow. The pipe can do considerable damage.

But this guard—easily constructed of scrap steel—can eliminate this danger. Moreover, it makes it unnecessary to boom the pipe down for short hauls.

With two conventional racks on the side of the truck, this guard—made in a box-like pattern to contain the pipe should it slip forward—is attached to the front bumper as shown. A ¼-inch steel plate covers the back as shown.

Patrol Planes Can Warn Workmen of Pipe Lines

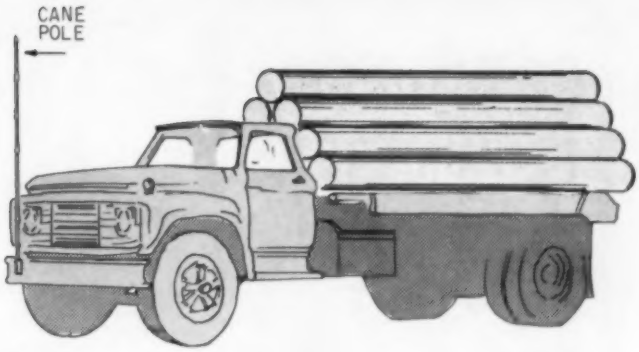
One of the most important tasks of patrol pilots is to watch for workmen who may dig into a high pressure line or set off explosives near it. Ordinarily, when the pilot spots activities near the line, he radios in to the nearest pipe line pump station, and then it is up to the pipe line maintenance department to send an observer to the jobsite, if necessary.

However, this involves a time lag, and on occasion, this can be serious.

Why not print up several sets of circulars—each with a different message which might suit different occasions. One could say—"You are working in the vicinity of ————————Pipe Line Company's high-pressure lines! If you don't know exactly where it is, please call our company at————————Phone No."

Such message circulars could be dropped at low level a dozen or so at a time—until the workmen pick one up. Then the pilot can proceed.

Each pilot will know the most desirable set of messages to carry.

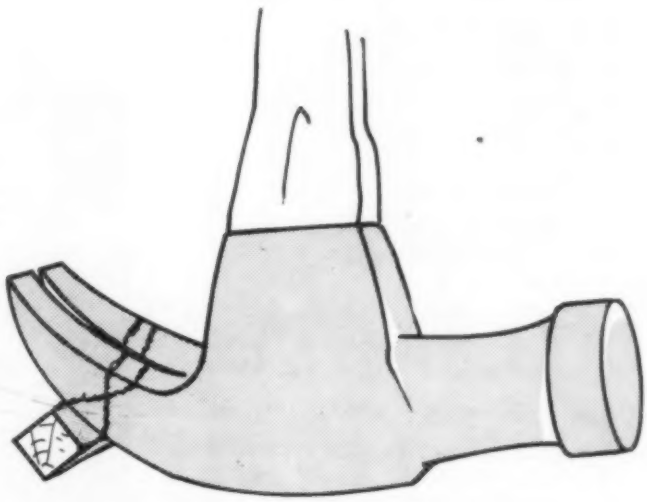


Fishing Pole Prevents Trouble at the Underpass

Sometimes, stringing contractors have to haul pipe over roads of yesteryear where clearance at the underpasses is scant. Thus, a tall load runs the chance of smacking into the top of the underpass—or perhaps ripping out low power and telephone lines.

A solution to this trouble at the "pass" is to mount a bamboo whip—a fishing pole, of course, on the front bumper which has been cut a few inches higher than the load. This telltale can prevent difficulties by warning the driver before it is too late.

For best results, weld a socket of a piece of pipe onto the front bumper, install a clamp and use tape to make a tight fit for the pole in its socket.

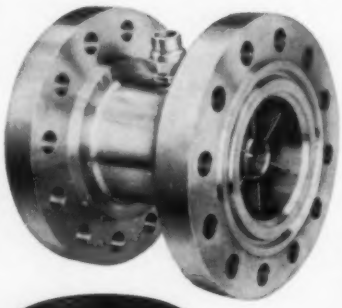


Small Block on Hammer Makes Nail-Pulling Easy

Any repetitive job lends itself to improvement. Take, for example, the problem of pulling nails. As often as not, a claw hammer will work best if a block is placed under it. Where there are lots of nails to pull and a block will help, why not wire a small oak block to the top of the hammer as shown. As a temporary measure, two rubber bands will suffice to keep the block in place.

To keep the wire from marring the surface of the wood, notch the block to counter-sink the wire.

COX TURBINE FLOWMETERS



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What's Happening among MEN in the INDUSTRY

Lowell E. Anderson has been appointed technical supervisor of stations for **Service Pipe Line Co.** succeeding **F. V. Cook,** who recently retired.

L. E. Anderson

Cook retired after 41 years service. Since last September he supervised more than 80 main line stations in the 15-state crude system. Anderson had been division chief engineer on special assignment in Tulsa. He presently is construction manager for Dixie Pipeline Company's eastern section. Service is supervising design and construction of the LPG line.

Sinclair Oil Corporation announces that **Capt. Mathew V. Carson, Jr.,** former administrator of mandatory oil imports program, has joined the Sinclair organization.

Carson was the director of the office of oil and gas, Department of the Interior, in 1958. This year he retired from the Interior Department and the Navy. He was awarded the Distinguished Service Gold Metal.

George E. Pierce, formerly controller and secretary, has been named a vice president of **Buckeye Pipe Line Company.** He will be headquartered in Houston.

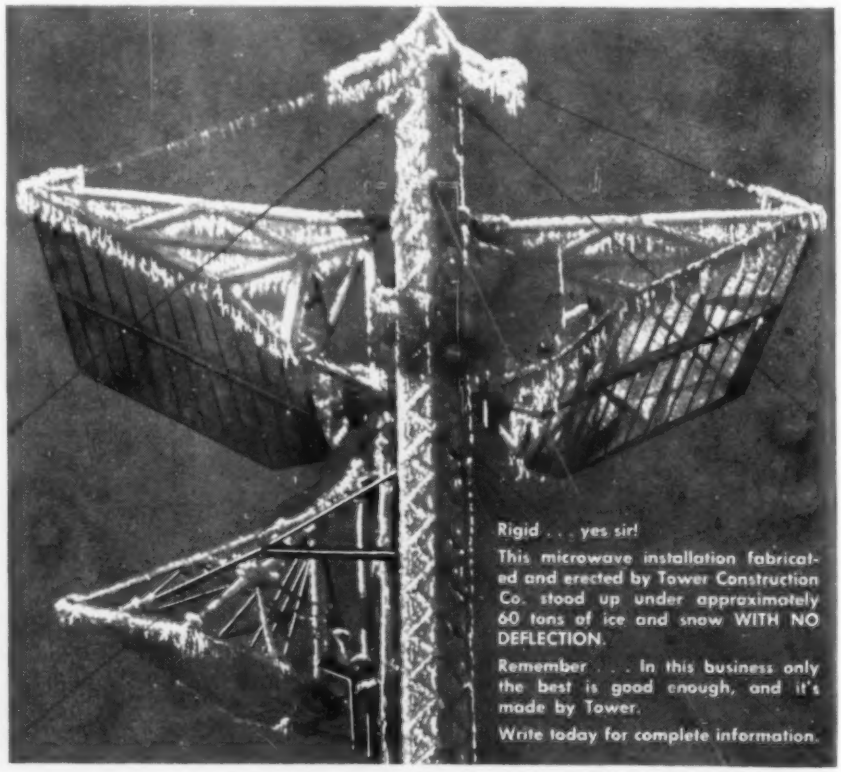
He joined Buckeye in 1955. Previously he had been with Rockwood & Co. He continues as Buckeye secretary.

Albert B. Alkek and **O. Guinn Smith** have been named directors of **Mid-America Pipe Line Company.** Alkek is president of the Alkek Oil Corporation and Smith is assistant dean of the Havard Business School, Boston.

Service Pipe Line Company announces several promotions and transfers. **Morrison Hynd,** senior engineer at Rawlins, Wyo,. becomes division schedule coordinator at Galesburg, Ill. **Thomas H. Weldon,** station foreman at Center, Mo., was moved to Craig, Colo. as district mechanic. **Lloyd E. Ricker** becomes district mechanic at Thermopolis, Wyo.

Patrick Murphy becomes schedule coordinator at Shawnee, Okla. He had been senior engineer at Shawnee. **Lewis Byrd,** oil movements coordinator at Casper, Wyo., has been assigned to Wichita, Kan. **Hershal Evans** has been appointed division schedule coordinator at Casper. He had been senior engineer at Casper.

An engineering consulting firm has been organized by **James A. Goolsbee** and **Dixon H. Cain** for design and feasibility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studies in natural gas, refining, and petrochemical industries.

Goolsbee has been chief process engineer for Tellepsen Petro-Chem Constructors and Cain was president of Fifteen Oil Company, which was merged with Tennessee Gas Transmission Company.

Alfred W. Martinelli, Buckeye Pipe Line Company assistant controller and assistant secretary, has been elected membership in the Controller Institute of America.

C. Ray Grosvenor has joined **Williams Brothers Company** to make special studies relating to development of project interests in transportation and petroleum processing field. He will be concerned primarily with domestic projects with headquarters in Tulsa.

C. Ray Grosvenor

Before joining Williams Brothers, Grosvenor had been with Lucey Products Corporation in charge of pipe lines, refining and chemical plants.

Texas Gas Transmission Corporation has acquired a controlling interest in Kentucky Electronics Inc., a small electronic component manufacturer in Owensboro.

Robert L. Geiler has been named director of training in the employe relations department for **Columbia Gulf Transmission Company.** He will plan and administer all internal training programs for Columbia Gulf.

Formerly Geiler was senior analyst in industrial relations department of Shell Chemical Company. He had been with Shell since 1956.

Donovan P. Dugan and **Edwin L. Ochs,** who served as president and secretary-treasurer of the **Tuscarora Pipe Line Company,** retired from the **Standard Oil Company** (N. J.) organization.

Dugan joined the company 30 years ago and moved up to president in 1959. Ochs served 31 years with Tuscarora and in 1954 was elected secretary-treasurer and a member of the board.

Humble Oil & Refining Company has formed a supply and transportation department with vice president **W. T. Moore** in charge. **D. M. Cox** has been named supply and transportation coordinator and four managers were named to assist him.

John G. Yeager, crude oil; **C. C. Garvin, Jr.,** product supply and distribution; **Haylett O'Neill,** purchasing; and **N. C. Dunn** for traffic were appointed managers.

Cox had been manager of supply and transportation. He joined Esso Standard in 1943 in Baton Rouge and moved to Houston in 1960. Yeager was manager of Humble Division's crude oil department. Garvin had been manager of Esso's supply department. O'Neill has been man-

If you have a special problem . . . we can help you!

TYPE HS 16" TO 36"

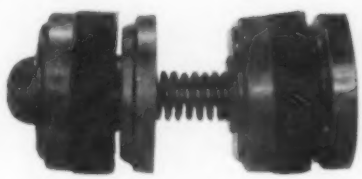
Lower Unit Cost . . .

★ HS Units do a complete cleaning job, are wear compensating with overlapping brushes mounted on 200# arch spring. HS units are more compact, have less weight, and are easier to handle. These units do a better water removal job than conventional batching unit. Check the price of this unit with the unit you are now using.

TYPE SR-F 6" TO 14"

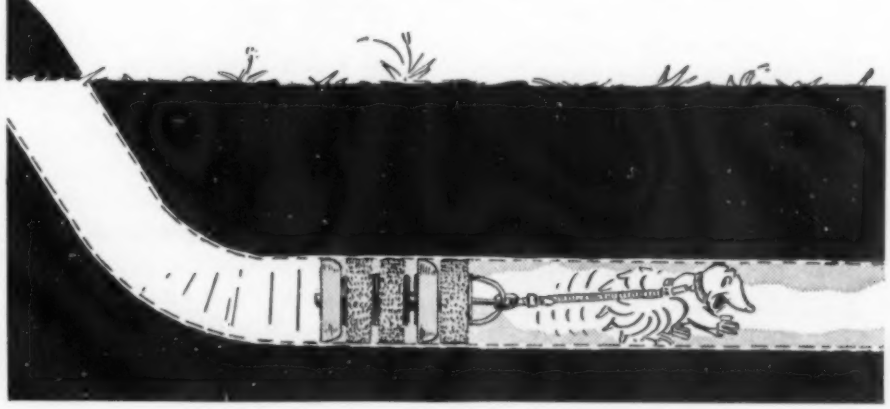
Special Design . . .

The SR-F was designed to satisfy the need for a cleaner which would clean the smaller size pipelines which have short radius bends. These units are designed to have two cups to hold a tight seal while the others are distorted in a 90° short radius bend. The heavy coil spring over the universal joint will straighten the unit in the line after it has gone around a sharp bend.



TYPE BS-3 & BS-4
3" To 36"
SHORT BATCHING UNIT
For Water or Air Displacement
Hydrostatic Testing

PIPELINE CLEANERS CO.
FORT MADISON, IOWA
PHONE DRake 2-2051
Manufacturers of Pipeline Cleaners Since 1936!



For more data on advertised products, use cards, last page.

ager of purchasing and Dunn was traffic manager at Baton Rouge refinery.

Samuel B. Barley succeeds **B. Frank Albanese** as LPG sales manager of Esso Standard Division, **Humble Oil & Refining Company.** Albanese recently retired. Barley has been in Esso's marketing division for 23 years.

G. V. Rohleder, Mid-America Pipe Line Co. engineer, has been elected president of the Pipe Liners Club of Tulsa for the 1961-62 year **D. A. Roach,** Mid-America vice president, was named vice president of the association. **W. A. Elliot, Great Lakes Pipe Line Company** was elected secretary and **H. G. Mariner** of **Service Pipe Line Company** was named treasurer. Directors appointed for a two-year term were **F. B. Neptune, Phillips Pipe Line Company** and **Walter E. Biery, Mid-Continent Pipe Line Co.**

Doyle S. Smith has been promoted to manager of **Continental Oil Company's** transportation department. He succeeds **C. O. Reeder,** who retired, and his headquarters will be located in Ponca City. Smith joined the company in 1954 as a transportation analyst and became assistant transportation manager in charge of the administrative division in 1957.

V. W. Meythaler

F. K. Rader, Jr.

Texas Gas Transmission Corporation has announced several promotions. Virgil **W. Meythaler** and **Franklin K. Rader, Jr.,** have been elected to the newly created positions of senior vice president. **Henry F. Keith** was named vice president in charge of purchasing, stores and aviation departments.

Henry F. Keith

Other appointments include **George W. Anders** and **Richard C. Young** who were named to the newly created positions of staff asistant to the president. **Paul A. Fedde** has been appointed director of research and **William T. Turner, Jr.,** was named director of planning.

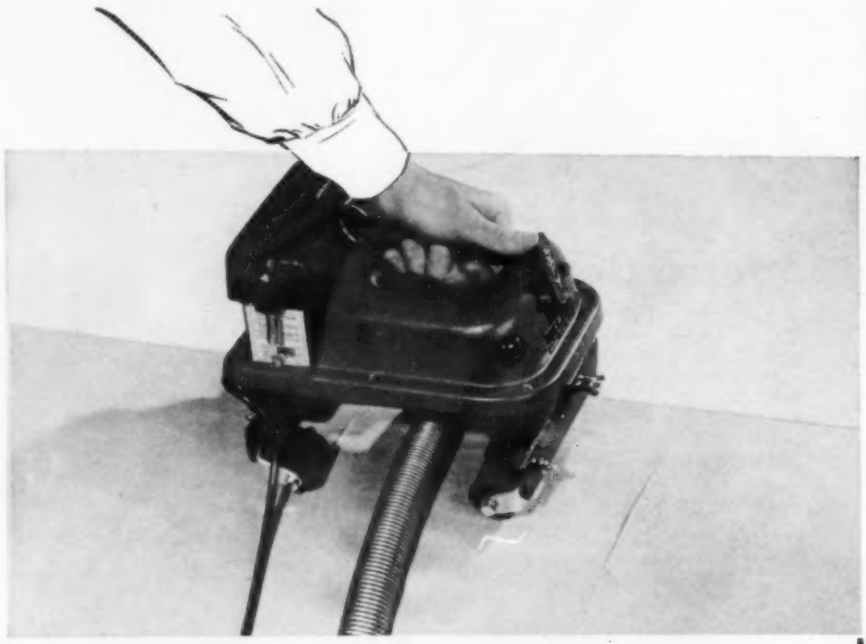
Rader joined the company in 1952 and was made a vice-president in 1957. Meythaler has been with Texas Gas since 1949 and became vice president in 1959. Keith became assistant treasurer and director of purchasing, stores, and transportation in 1947. Young has served as assistant to the vice president since 1956. Anders was named director of financial relations in 1960. Turner and Fedde were senior research engineers.

Several **Texas Eastern Transmission Corporation** employes will transfer from Shreveport to new Houston headquarters. **Baxter D. Goodrich,** senior vice president Gas Division; **Walter E. Caine,** vice president, Gas Sales Department; **S. P. Osborn,** comptroller; and **J. F. Weiler,** attorney are among those transferring.

Departments and sections moving include budget and forecasting, purchasing, transportation, insurance, gas sales, gas rates, rights of way and employe relations. Some 30 employes in operating, accounting, and engineering departments will move also.

H. A. Eddins, president of **Oklahoma Natural Gas Company,** has been elected president of the Southern Gas Association. **Clayton L. Nairne, New Orleans Public Service Inc.,** was named first vice president and **Buell G. Duncan, Piedmont Natural Gas Company, Inc.,** was elected second vice president. Other officers for 1961-62 include **Jack A. Bell, Gas Light Company of Columbus,** secretary and **B. F. Wombacker, Southern Union Gas Company,** treasurer.

W. C. McGee, Jr., Tennessee Pipeline Company was appointed chairman, and **Hugh F. Steen, El Paso Natural Gas Company,** vice chairman of the Advisory Council.



BE SURE!

ELIMINATE HOLIDAYS and their consequences with accurate, reliable SPY Holiday Detectors. Compact and light in weight for one-man operation. Carrying or rolling models available. Detectors set to your job specifications:

- **all voltages**
- **all pipe sizes**
- **all types coatings**

Anywhere in the world
SPY
HOLIDAY DETECTORS
are as near as your telephone. In emergencies our own plane assures immediate service.

Spy Detector
QUALITY SERVICE

is there . . . when you need it

Pipeline INSPECTION CO., Inc. Day or Night Phone BA 1-6036
2104 Wyandotte Street • Kansas City, Missouri

Natural Gas Pipeline Company of America has appointed **Walter B. Verner** superintendent of production, Houston operation. Verner had been gas supply engineer in production headquarters in Amarillo, Texas. He succeeds **Charles R. Worst** who has resigned.

Gulf Oil Corporation has elected two executive vice presidents and a senior vice president. **I. G. Davis** and **J. E. Bounds** were named executive vice presidents and **B. R. Dorsey** becomes a senior vice president. Dorsey, previously administrative vice president and coordinator of the Manufacturing Department, will handle product transportation and supply, and refining and petrochemicals areas.

WHO'S MEETING WHERE

September

ISA, Fall Instrument-Automation conference and exhibit, Biltmore Hotel, Memorial Sports Arena, Los Angeles, September 11-15.

Pacific Coast Gas Association, convention and annual meeting, Coronado Hotel, Coronado, Calif., September 13-15.

NGAA, Rocky Mountain Regional meeting, Northern Hotel, Billings, Mont., September 14.

AIEE, petroleum industry conference, New Orleans, September 17-20.

ASME, petroleum division conference, Muehlebach Hotel, Kansas City, September 24-27.

October

AGA, 43rd annual convention, Statler Hilton Hotel and Municipal Auditorium, Dallas, October 1-4.

NACE, Western Region Conference, Hotel Multnomah, Portland, Ore., October 4-6.

NACE, North Central Region Conference, Chase Park Plaza Hotel, St. Louis, October 9-11.

ASME-ASLE, lubrication conference, Morrison Hotel, Chicago, October 17-19.

American Society for Metals, 43rd national congress, Cobo Hall, Detroit, October 23-27.

NACE, South Central Region Conference and exhibition, Shamrock-Hilton, Houston, October 24-27.

NGAA, Southern Regional meeting, Carlton Hotel, Tyler, Texas, October 27.

NACE, Northeast Region Conference, Hotel Statler, New York City, October 30-November 2.

November

API, annual meeting, Chicago, November 13-15.

NGAA, Panhandle Plains Regional meeting, Herring Hotel, Amarillo, Texas, November 17.

View of 36″ pipe being laid by H. C. Price Company near Tule Lake, California, using a 12″ Swing Sling.

H. C. Price reports:

Swing Slings* last longer and provide greater safety

"Our CF&I-Wickwire lowering-in sling is providing three times the service life available from competitive makes," asserted Mr. Bob Orr, bending foreman, H. C. Price Company of Bartlesville, Oklahoma.

"Other type slings wore out within a few days, generally not more than four," continued Mr. Orr. "Dramatically contrasted against this dismal record are the high-strength cables, covered with neoprene, which make the Swing Sling virtually indestructible. After 12 working days, there was no visible evidence of wear."

Price has also found that the Swing Sling is exceptionally safe. It takes punishment readily and the flexible edges do not roll with the load and rip as other slings do. Its superior grip eases worries about clamps slipping or rolling to correct sag or overbend.

The Swing Sling is made in five "pipeline" models, in any length over 4′ and in widths of 12″, 18″, 24″, 30″ and 36″. Get the full story from any CF&I-Wickwire sales office or distributor. 8332

*Trademark—Patent Pending

The Colorado Fuel and Iron Corporation
Denver • Oakland • New York
Sales offices in Key Cities

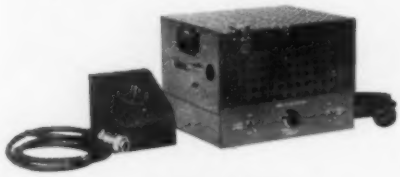
For more data on advertised products, use cards, last page.

Protective Coating Inspection Problems?

Here's Your Answer

No matter whether you're coating a pipeline or a chemical tank, continuity is vital. Use of a Tinker and Rasor Holiday Detector while the job is open, can save days of downtime later on.

• PLANT AND YARDS

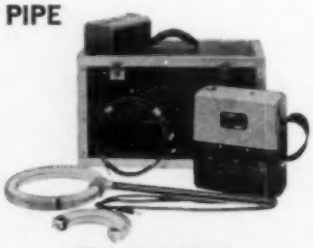


Tinker and Rasor
EPAC Holiday Detector or J-1ACM

EPAC operates off 110 volts A.C. power for stationary coating operations. Internal voltage adjustment from 5,000 to 20,000 volts or with external variable transformer from 500 to 6,000 volts, or 5 KV to 20 KV.

J-1ACM for continuous inspection on coating and wrapping machines which use water for cooling.

• PIPE



Tinker and Rasor
E-P or E-4 Holiday Detectors

Output adjustable from 5,000 to 20,000 pulsating voltage.

E-P—All purpose for larger diameter pipe, damp or dry climate, pre-fab film or hot applied coatings.

E-4—Lower cost, dry surface type of detector specifically designed for smaller diameter pipe and flat surfaces.

• THIN FILM

Tinker and Rasor
M-1 Holiday Detector

For painted or sprayed thin film coatings such as vinyls and epoxies. Maximum applied voltage 67½ V., non-destructive to coatings. Belt mounted, 4-lbs. total weight.

• UNDERGROUND

Tinker and Rasor
Pearson-type Holiday Detector

For detecting holidays and electrical shorts without uncovering the pipeline. Completely transistorized . . . generates 15 watt, 750 cycle, stable A.C. Audio-frequency signal. Adaptable to null search method.

Tinker and Rasor has prepared a complete data kit which describes the null search system as well as other recommended procedures for inspecting protective coatings. Material includes technical data on equipment, general discussion of types of detectors, theory of operations, etc.

Engineering Note:
To insure a perfect application, include Tinker and Rasor Holiday Inspection. Write for specification guide.

Quality Control for Coating Application

TINKER & RASOR

213 Agostino Road, P.O. Box 281 • San Gabriel, California

What's Happening Among Service and Supply Men

Allis-Chalmers Manufacturing Names Larmore Assistant General Manager

H. T. Larmore has been named assistant general manager for Allis-Chalmers Manufacturing Company Construction Machinery Division. He had been general products manager since 1960.

H. T. Larmore

Larmore has been with the company since 1936 and in 1945 became crawler tractor and allied equipment sales manager, a position he held until becoming general products manager. He will be located in Milwaukee.

C. F. Borden Elected to Kaiser Steel Corp. Board

C. F. Borden, executive vice president of Kaiser Steel Corporation, has been elected to the board of directors. He has been with the company since 1945. In 1950 he became vice president in charge of sales and was made executive vice president in 1959.

He is serving on the American Iron and Steel Institute's committee to promote the use of steel.

Koehring Division President To Handle Overseas Activities

E. A. Brugger, president and general manager of Koehring Division of Koehring Company will relocate in Paris, France and handle the company European and overseas activities.

He was named a Koehring vice president in 1948 and served on the board since 1950. He became president and general manager of Koehring Division in 1956.

Robert M. Pearson Named Nordberg Representative

Nordberg Mfg. Co. has named Robert M. Pearson a special representative in the Great Lakes district. He will be headquartered in Pittsburgh, Pa. covering assignments out of the Cleveland office.

White Diesel Names Woodman Houston Sales Representative

George M. Woodman has been appointed a sales representative in Houston for White Diesel Engine Division of White Motor Company. He has been selling compressors and engines since 1956 for another major firm. Woodman is a member of the AIME, ASME and TSPE engineering societies.

Protection Is Our Business / Asbestos Pipe Wrap Our Product

The first line of defense for your pipe lines has to be the pipe wrap you use. ■ When you specify Nicolet Asbestos Pipe Wraps you are preparing your pipe line for a winning battle against corrosion, abrasion, enamel sag and soil stresses. ■ You can successfully combat all possible conditions with either Nicolet #15 "Standard", #8 "Tufbestos" #10 "Reflecto" (the new, improved, white Asbestos Felt) and "Old Nic" Glass Wrap. ■ Write today for specifications and samples of the full line of Nicolet pipe protection products.

Distributed throughout the United States

NICOLET INDUSTRIES, INC.

FLORHAM PARK, NEW JERSEY

For more data on advertised products, use cards, last page.

Moisture removal for third magnaflux test of every length of E.W. line pipe

TEST

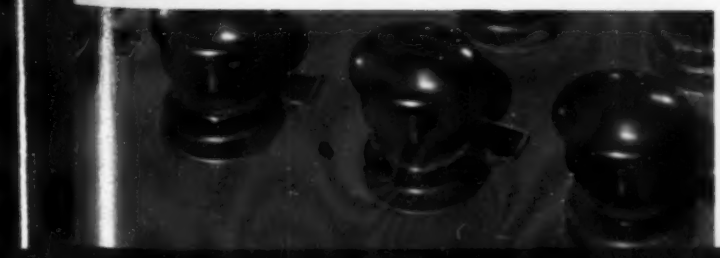
quality control tests make sure Youngstown line pipe won't fail in the field

Take the pipe and check the weld. Then crush an end. Burst a length. Pressure-test it hydrostatically. From ore to steel to final stenciled product, separate mechanical and visual inspections make sure Youngstown line pipe won't fail in the field.

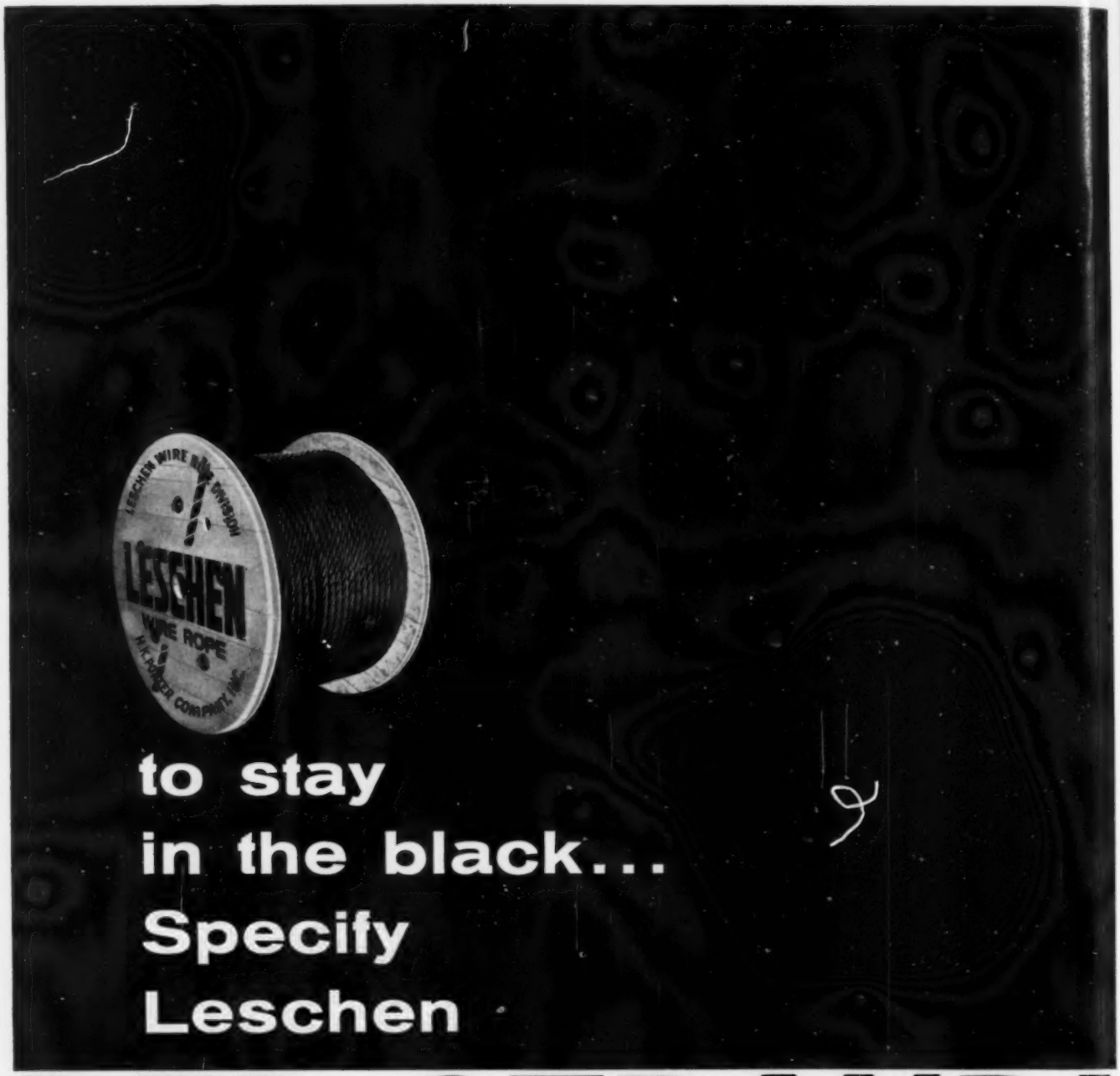
Get Youngstown Electric Weld line pipe in sizes 6⅝" to 22" O.D. Get it in time and money-saving long lengths to 55 feet. Order Youngstown Seamless line pipe in sizes 2⅜" to 14" O.D., Continuous Weld line pipe in sizes ⅛" nominal to 4½" O.D. Get it fast, when and where you want it, through Youngstown District Offices, through any one of 900 independent pipe distributors.

Count on Youngstown for line pipe you can depend on. For gas and oil gathering, transmission and distribution lines. For product lines from petrochemical plants and refineries. For quality pipe wherever line pipe is needed. You get value and performance when you buy line pipe from Youngstown, world's second largest pipe producer.

Youngstown – growing force in steel



For complete information about Youngstown line pipe, write Dept. 18-B,
The Youngstown Sheet and Tube Company, Youngstown, Ohio.



RED-STRAND!

Black . . . the most attractive color in bookkeeping. There's no magic formula for staying in the black, but careful consideration of the right type and make of wire rope can cut costs substantially—10%, 20% or more.

RED-STRAND users are accustomed to longer-than-expected wire rope service, because higher-than-catalog-rated quality is built into the rope. They know that Leschen distributors and field men make sure they have the best rope construction for the job at hand. They know, and you can too, that for wire rope and sling needs—specify RED-STRAND and stay in the black! For the name of your nearest Leschen distributor write: Leschen Wire Rope Division, H. K. Porter Company, Inc. 2727 Hamilton Avenue, St. Louis 12, Mo.

PORTER

LESCHEN WIRE ROPE DIVISION
H. K. PORTER COMPANY, INC.

Southern Pipe Division Promotes Charles E. Lamar

Charles E. Lamar

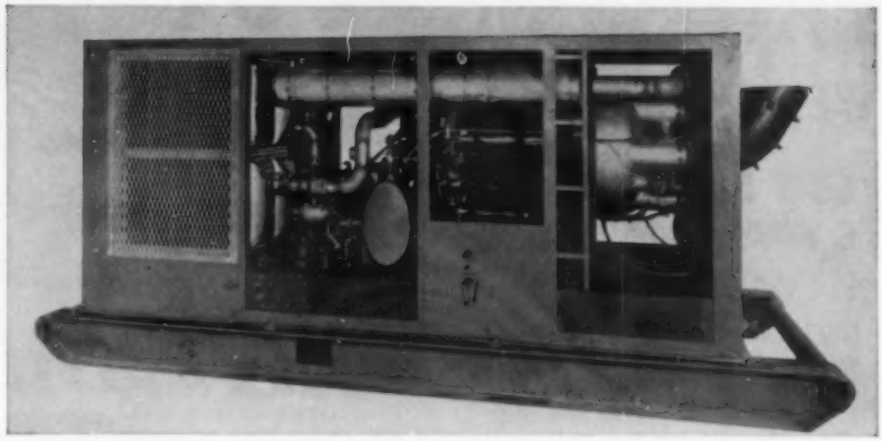
Charles E. Lamar has been appointed executive vice president of Southern Pipe Division of U.S. Industries, Inc. Lamar has been with the company since 1951 when he became a sales engineer. In 1957, he was named assistant sales manager and became manager of sales and director of the division in 1959. He was elected vice president of marketing in 1961.

General Electric Co. Promotes E. L. Kapernaros

E. L. Kapernaros has been named manager, diamond application engineering, metallurgical products department, General Electric Company. He joined the department in 1956 and for the past two years he has been serving as an application engineer for the diamond product section.

Heyck Equipment Named Sales Representative

Heyck Equipment Company, Inc., Houston, has been named a sales representative for Dean Hill Corporation, Indianapolis, Ind. Heyck territory will include South Texas and Lake Charles, La. areas for centrifugal pumps sales.



Packaged Gas Turbine Power

Mission Manufacturing Company recently demonstrated its new packaged gas turbine power units featuring turbines in the 35 to 850 hp range. These turbines are manufactured by AiResearch Manufacturing Co. The round power package consists of gas turbine, compressor and power unit mounted on a skid, enclosed against the weather, with heat exchanger, operating controls, and safety devices.

D. A. Milligan Appointed J. I. Case General Manager

D. A. Milligan has been appointed general manager of marketing and product development and J. P. Cody has been named general sales manager of the industrial division for J. I. Case Company.

R. P. Meyers becomes Industrial Eastern Division manager succeeding D. H. Mitchell, who resigned. J. R. Haley replaces Meyers as North Central Regional manager. Milligan was head of Case Industrial sales department and Cody had been Midwestern Division manager.

Tube-Turn Appoints Distributor in Libya

Tripoli Sales Company has been appointed a distributor in Libya for Tube-Turn Division of Chemetron Corporation to handle fittings, flanges and other piping components. Libya is the 42nd country in which the division has one or more distributor locations.

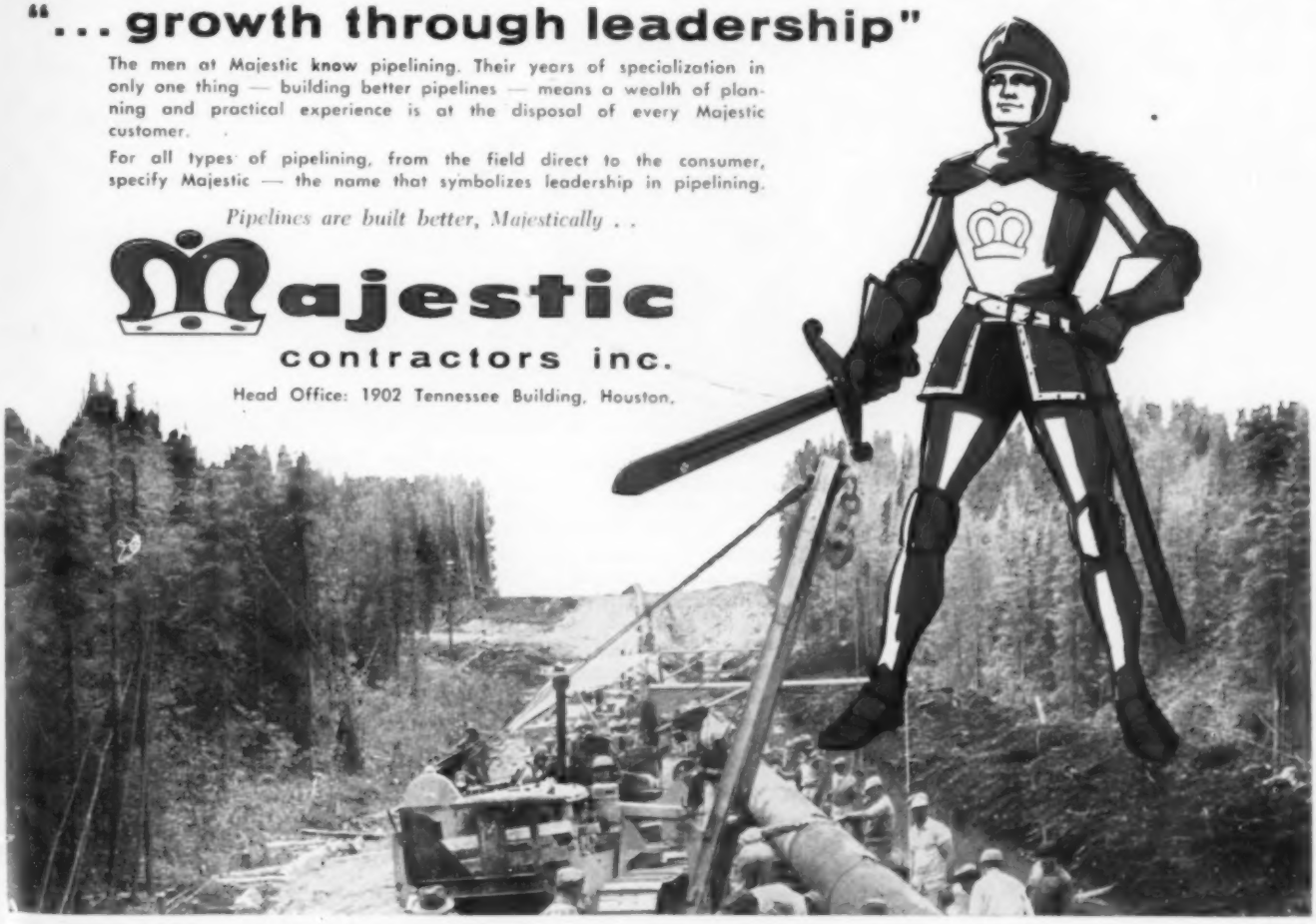
"... growth through leadership"

The men at Majestic know pipelining. Their years of specialization in only one thing — building better pipelines — means a wealth of planning and practical experience is at the disposal of every Majestic customer.

For all types of pipelining, from the field direct to the consumer, specify Majestic — the name that symbolizes leadership in pipelining.

Pipelines are built better, Majestically . .

Majestic
contractors inc.
Head Office: 1902 Tennessee Building, Houston.



FLEET-LINE®

WELDING FITTINGS

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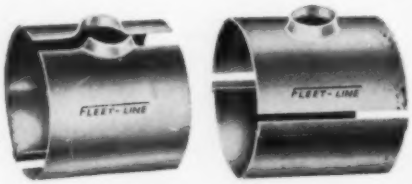
LITERATURE BY AIR MAIL...

...ask for it now.

REDUCERS: Concentric and eccentric. Nominal pipe sizes 1" to 30", ASA B16.9, ASTM A234. Schedules 10 to 160, stainless steel, and other alloys. Special lengths and sizes.

SADDLES: Conventional, and for pressure vessel heads. Nozzle sizes from ¼" to 24". Fleet-Line saddles weld neatly into place in much less time, and with much less welding rod.

Full encirclement saddles.



REDUCING TEES, Forged Steel Manifold Type.

Dealers and Stocking Distributors throughout the United States and Canada.

All orders acknowledged by air mail or long distance telephone and filled at once.

STEEL FORGINGS, Inc.

P. O. Box 276K • Shreveport, La.

L. L. McBurney

J. E. Smith

Smith Welding Announces Change in Name, Officers

Smith Welding Corporation announces a new corporate name, opening of a new division and a change in officers. Smith Welding becomes a division of Tescom Corporation along with a new division—Fluid Systems Division. Tescom is derived from The Elmer Smith Company of Minnesota, named after its founder Elmer H. Smith, chairman for 12 years.

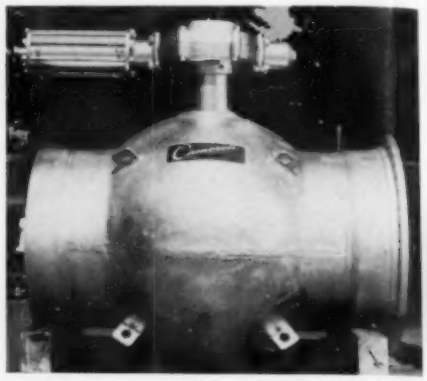
Smith becomes honorary chairman and L. L. McBurney is promoted from president to board chairman. Jack E. Smith becomes president and G. C. Swenson will be secretary.

The Fluid Systems Division will design and manufacture regulation equipment for control of pressures up to 10,000 psi.

Chicago Pneumatic Tool Names Chairman, President

Chicago Pneumatic Tool Company announces the election of Guy J. Coffey as chairman of the board and chief executive officer and Norman Readman president. Coffey succeeds H. Arnold Jackson who continues as a director and chairman of executive committee. Readman, formerly managing director of all overseas operations of the company, replaces Coffey.

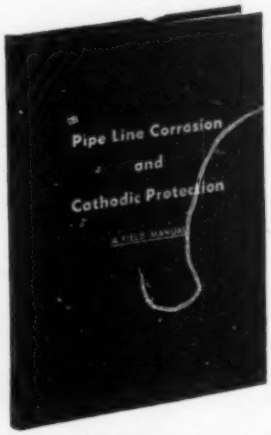
Thomas F. Noonan was named vice president and comptroller. Carra L. Lane was elected vice president and manager of plant operations.



42-Inch Ball Valve

Cameron Iron Works, Inc., has completed a 42-inch ball valve for use on a 42-inch pipe line from storage on shore to a marine loading platform in the Mediterranean. The valve is a 300 pound ASA classification, 720-pound working pressure, and 1,000-pound test pressure. It is equipped with a 175-pound 42-inch flange as the pressure downstream from the valve will be negligible.

The hydraulic operator installed on the valve opens and closes the unit in 30 seconds.



The most practical on-the-job manual for men concerned with pipe line corrosion.

Pipe Line Corrosion and Cathodic Protection

By MARSHALL E. PARKER

This book is designed as a practical field manual. It provides workable methods that can save you valuable time and effort in obtaining interpretive field data.

Contents (Condensed). Soil Resistivity Surveys, Pipe-to-Soil Potentials, Line Currents, Current Requirement Surveys, Rectifier System for Coated Lines, Ground Bed Design and Installation, Magnesium Anodes on Coated Lines, Hot Spot Detection, Stray Current Electrolysis, Interference in Cathodic Protection, Operation and Maintenance, Coating Inspection and Testing.

Appendices cover: Fundamentals of Underground Corrosion, Basic Principles of Cathodic Protection. Plus . . . tables and properties of metals, attenuation equations and index.

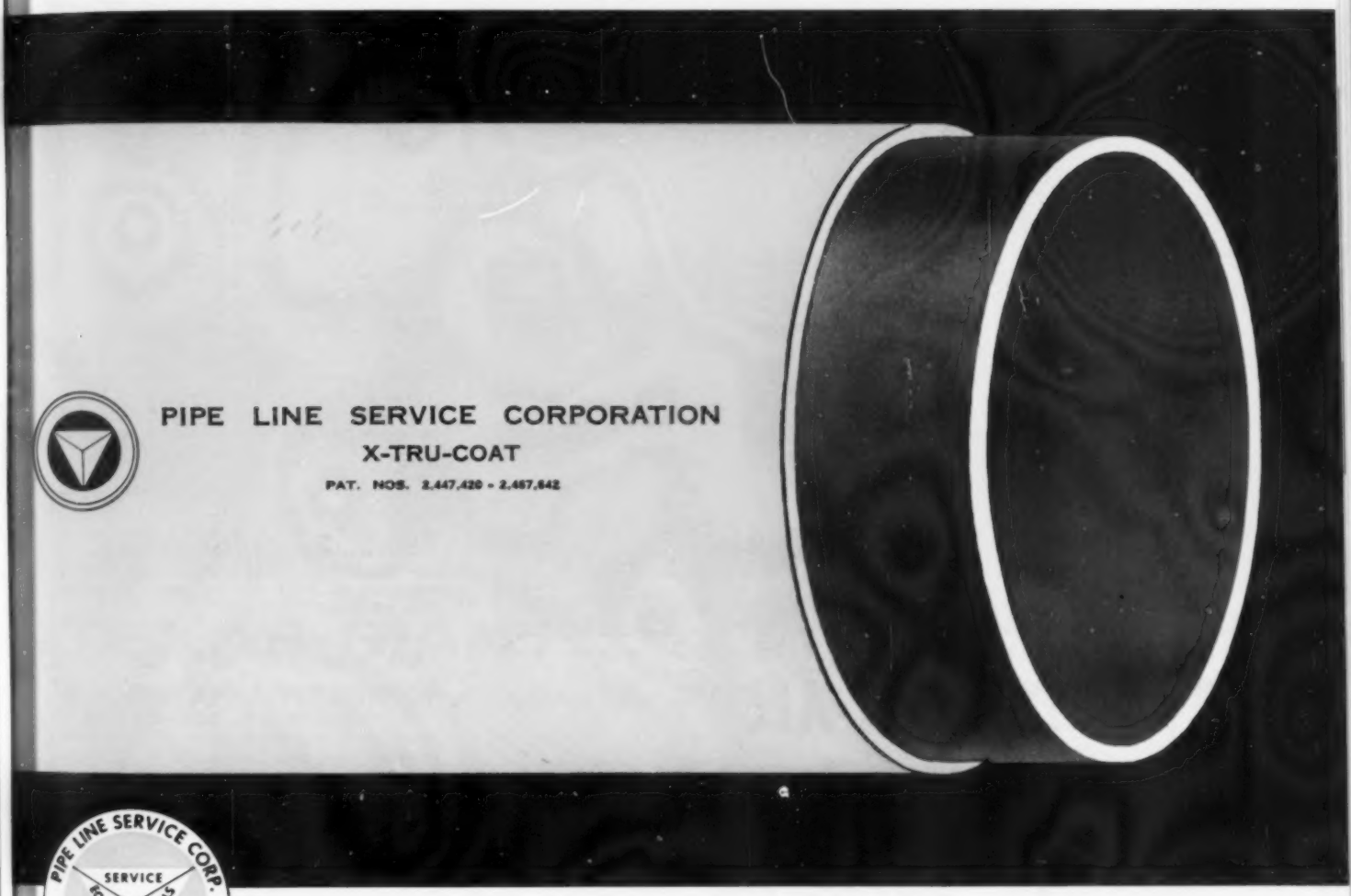
108 pages, illustrated. . . . Price $3.00

Send for your FREE copy of the New Petroleum Book Catalog which describes the nature and contents of many books pertaining to the Petroleum Industry.

ADDRESS:

Book Department
GULF PUBLISHING COMPANY
P. O. BOX 2608
HOUSTON 1, TEXAS

PIPE LINE SERVICE CORPORATION
now offers
X-TRU-COAT



Contributing once again to the progress of the Gas and Oil Industry, Pipe Line Service Corporation, pioneer in the field of steel pipe protection, offers you the application of X-TRU-COAT.

X-TRU-COAT is a High Density Polyethylene extruded on steel pipe over a pressure sensitive adhesive, produced under the Dekoron process.

Pipe Line Service is the first Independent Coating Company to apply X-TRU-COAT, and is now offering *Immediate, Unlimited Production* at our Sparrows Point, Maryland and North Lima (Youngstown), Ohio plants. On pipe sizes ½" through 4½" O.D., X-TRU-COAT will be available at our Franklin Park, Illinois plant after October 1st, 1961.

For prices and complete information about this new service, call or write Pipe Line Service Corporation, P. O. Box 318, Franklin Park, Illinois.

Pipe Line Service Corporation

A SUBSIDIARY OF AMERICAN STEEL FOUNDRIES

General Offices and Plant: Franklin Park, Ill.

Quality pioneers in coating and wrapping pipe for over a quarter century

Fox Steel Corp. Names Fielder Vice President

William H. Fielder has been elected vice president in charge of operations for Fox Steel Pipe Corporation. Prior to his promotion, he had been plant superintendent of Fox plant in Jacksonville, Fla.

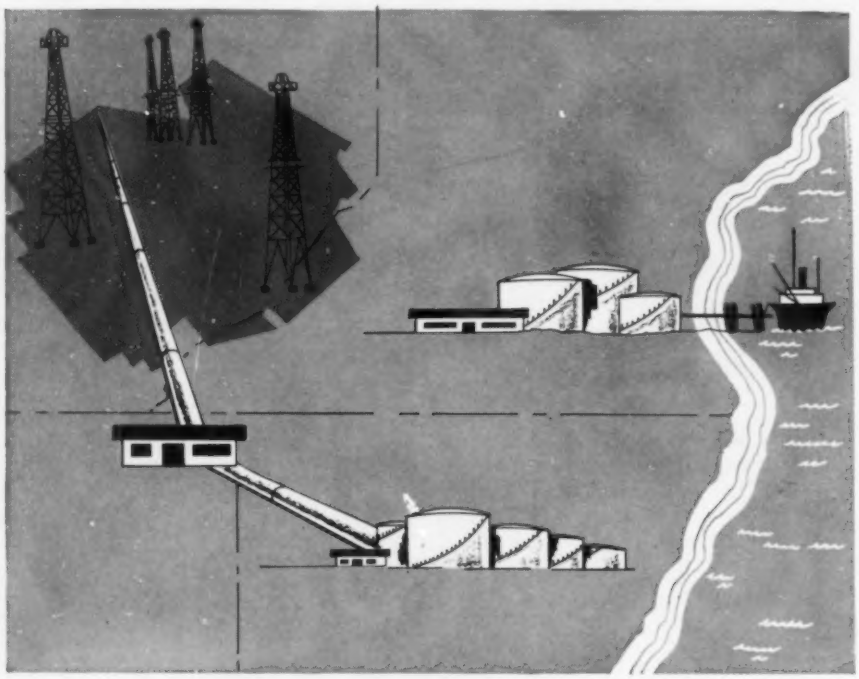
Roman Heads Plymouth Pipe Protection Division

E. A. Roman has been appointed manager of pipe protection department in the tape division of Plymouth Rubber Company, Inc. Roman has had experience as an engineer and sales executive in corrosion prevention field. He will be headquartered in Houston.

Chicago Bridge & Iron Co. Appoints Four Executives

Chicago Bridge & Iron Company has elected H. J. Clarke and S. C. Hamilton senior vice presidents and J. T. Horton and M. G. Mitchell vice presidents. Clarke presently is in charge of the company's operating department. He joined CB&I in 1927. Hamilton has been a director since 1946 and had been vice president—sales.

Horton, formerly manager of special designs and estimating, will be vice president—research. Mitchell, previously assistant sales manager, becomes vice president and manager of sales.



IT'S LATEX FOR ALL YOUR PIPELINE NEEDS!

Qualified by experience to handle any construction problem for the oil and Gas Pipeline Industry.

LATEX

LATEX CONSTRUCTION COMPANY

SERVING THE OIL AND GAS INDUSTRY FOR OVER 1/4 CENTURY

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Larry J. Stroman

J. R. Wilson

Daniel Orifice Fitting Co. Forms Electronics Division

Daniel Orifice Fitting Company, manufacturer of fluid metering devices, has entered the electronics field and has formed a new division. Larry J. Stroman has been appointed head of Daniel Electronics. Stroman formerly was manager of test instrument engineering at Dresser Electronics, SIE Division.

J. R. Wilson has been transferred from Los Angeles to Houston to assist Stroman. James G. Cernosek, an electronics technician, has joined the company's new division.

Allis-Chalmers Appoints K. R. Geist General Manager

Kenneth R. Geist has been named general manager of the newly formed special products department of Allis-Chalmers Manufacturing Co. Fred J. McDougall, assistant to director of purchases since 1952, succeeds Geist as director of purchases.

Allis-Chalmers also announces the appointment of Douglas W. Erskine as manager of engine engineering at Harvey Works. He replaces A. F. Ochtman who retired. George E. Hall has been named manager of sales development, construction machinery division.

Jones & Laughlin Supply Co. Announces Four Appointments

Four members of the field sales force of Jones & Laughlin Supply Division have received new assignments. H. B. Carruth, Jr., has been appointed a salesman at Longview, Texas. B. E. Irby has been transferred as salesman from Longview to Ruston, La.

J. B. Williams becomes salesman-supervisor with headquarters in Mexia, Texas. A. A. Bell was appointed salesman at Luling, Texas.

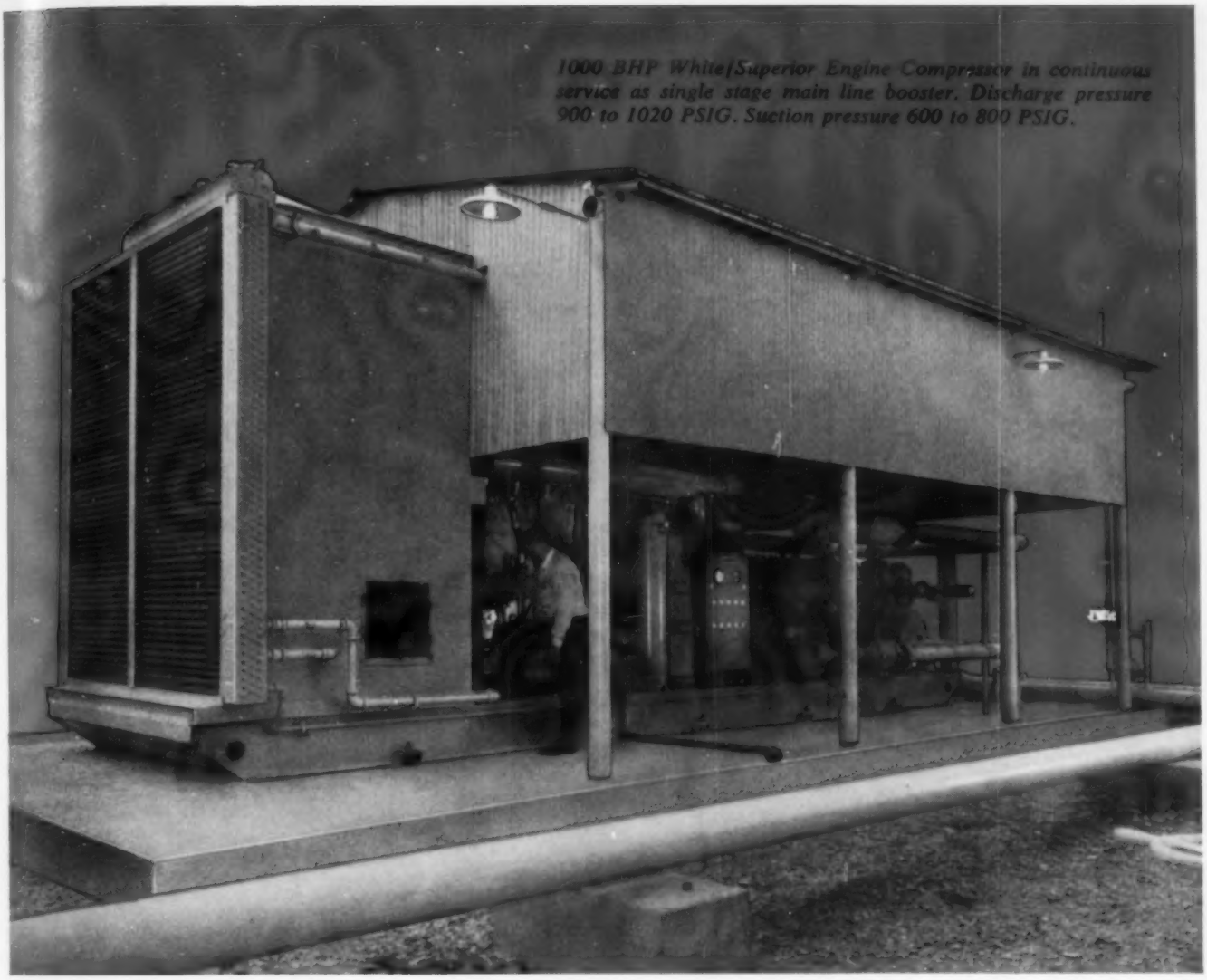
Pipe Line Service Corp. Completes Coating Plant

Pipe Line Service Corporation has opened its 94,000 square foot coating and wrapping plant in North Lima, Ohio, outside Youngstown.

The plant is the company's eighth and its second to carry facilities for X-Tru-Coat application.

A. C. Brodie Promoted by Badger Manufacturing Co.

A. C. Brodie has been named assistant to the president by Badger Manufacturing Company. He has been with the company since 1957. Previously he had been vice president of Feedback Controls.



1000 BHP White/Superior Engine Compressor in continuous service as single stage main line booster. Discharge pressure 900 to 1020 PSIG. Suction pressure 600 to 800 PSIG.

TEXAS GIANT... *1000 BHP WHITE/SUPERIOR*

ENGINE-COMPRESSOR AT COASTAL STATES GAS PRODUCING COMPANY

This White W-64 four-cylinder compressor, driven by a Superior 8GX-825 supercharged gas engine, develops 1000 BHP at 900 RPM. One of the highest HP units of its type in operation today, it has a capacity in excess of 50 MMSCFD. This *matched design* engine-compressor set is on duty at Coastal States Gas Producing Company's station, south of Houston, near Manvel, Texas.

White's medium speed, heavy duty, balanced opposed compressors—200 to 1000 BHP—are specifically engineered for direct drive combination with Superior natural gas engines or electric motors. Two, four and six-cylinder models offer cylinder sizes from 4000 PSI, 2⅝" dia. to 85 PSI, 22½" dia., providing 68 different cylinders. Custom sizes and designs are also available.

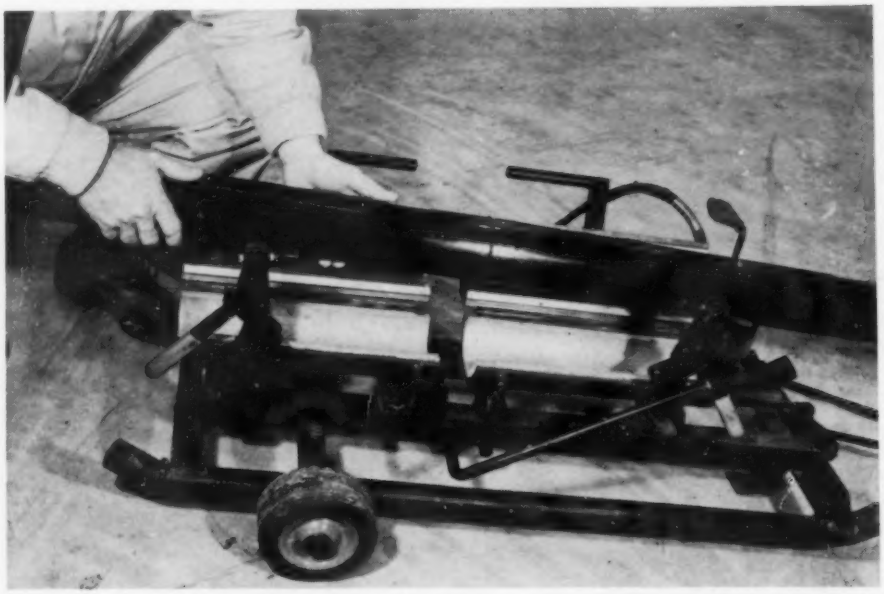
Compact packaged units can be engineered to your most exacting requirements for gas lifting, boosting, repressuring, peak shaving or underground storage applications. Get new Bulletin 124. White Diesel Engine Division, Springfield, Ohio.

White DIESEL | Superior ENGINES

White Diesel

For more data on advertised products, use cards, last page.

What's New in EQUIPMENT



Polyethylene Pipe

For use in gas gathering lines and other pipe applications, Phillips Chemical Company has developed a polyethylene pipe that has undergone six years of testing on Phillips Petroleum Company oil and gas lines.

One of the main features of the Marlex high density polyethylene pipe is its method of joining (butt-fushion) which reduces time and cost. Other features include corrosion, maintenance, lightweight material, and inside wall smoothness.

Phillips has installed more than 2 million feet of this pipe, mostly in gas fields.

In the pipe joining process, pipe ends are squared off and placed in line-up clamps. An aluminum plate heated to 400° F is inserted between two ends. After 30 seconds exposure to the heated plate, pipe ends soften and plate is removed. The two molten ends then are pressed together and after about 20 seconds cooling time the joint is completed and pipe is ready for the ditch.

For more data, circle **No. E1** on Readers' Service Card, last page this issue.

Transmitter

A new series of Transcope flow and differential pressure transmitters has been introduced by Taylor Instrument Companies. Features include a liquid-filled, diaphragm-sealed primary unit which is designed for hydraulic overrange protection to full static pressure of 1500 psi applied to either of the pressure ports. The units extract the square root from flow measurement by calibration. The calibration may be adjusted to give a linear output which is proportional to the differential pressure.

Providing a standard 3-15 psi output, these instruments are available in either an indicating or a blind form, with a transmission accuracy of ½ percent over a continuously adjustable range at 20 to 250 inches of water (differential pressure).

(This item supplements Taylor Instrument Companies data on page 456 of The Pipe Line Catalog, Third Revision.)

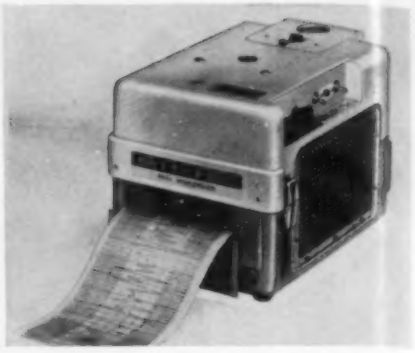
For more data, circle **No. E2** on Readers' Service Card, last page this issue.

Fuel Injection Cages

Fuel injection cage assemblies with several innovations are offered by Delta-Wesco Manufacturing Company for Clark Bros. Co. and Cooper-Bessemer Corp. engines.

Improved alignment of valve and seat are accomplished with a series of self-lubricated aligner bushings and sealed with Teflon packing. Cages are designed to provide a turbulence that improves mixture of air and gas. Features include Stellited seat and valve head and hard chrome valve stems.

For more data, circle **No. E3** on Readers' Service Card, last page this issue.

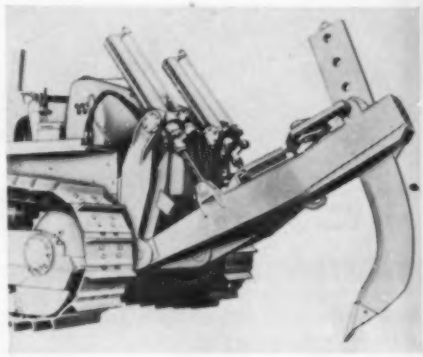


Oscillograph

A direct-recording oscillograph with an optional built-in flash timer that produces full-width time lines on recording paper at any of three intervals has been introduced by Minneapolis-Honeywell's Heiland division.

The viscicorder 960C employs a timing circuit that can be triggered externally by either supplying pulsing voltage of 10v at 20K ohms impedance, or by causing impedance to drop to 100 ohms or less through shorting-out or other means. The time signal can be used as an event market related to shaft rotation, belt movement or any other effect that can more conveniently be fed to the timing circuit than to a galvanometer. The unit permits recording as many as 14 channels of scientific or test data simultaneously, each at frequencies up to 5,000 cycles per second.

For more data, circle **No. E4** on Readers' Service Card, last page this issue.



Ripper Improvements

Improvements to increase service life and reduce operating costs of Kelley D9 Model C ripper have been announced by Kelley Products Division of Crutcher, Rolfs, Cummings, Inc. Use of a higher strength, higher alloy steel has permitted more compact, light-weight units while wear resistance has increased. Also the new model is easier to install.

Both single and triple shank models are offered with a wide variety of shank types and boots that fit the machine for any material. The welded box section tool bar is controlled by 7-inch diameter double acting cylinders with 48-inch stroke.

For more data, circle **No. E5** on Readers' Service Card, last page this issue.

Butyl-vinyl Tapes

A new 15-mil laminated butyl-vinyl pipe line tape is available from BuPol Special Products Division of Plicoflex, Inc. Also the division will offer laminated

GROVE G-6 REGULAR PORT VALVE SIMPLE—COMPACT—VERSATILE

For Manifolds, Headers, General Pipeline service

Now the proven Grove Seal-"O"-Ring® design is ready in a compact regular port gate valve. Round opening (1) assures flow characteristics superior to plugs. Double-barrier seal gives positive metal-to-metal contact (2) backed up by protected o-rings (3) to keep gate clean, smooth for fast open/close. Non-rising stem (4) and "designed-in" compactness achieve overall height of only 14⅜". G-6 Regular Port gate valves, like all Grove valves, do not rely on sealing compounds for bubble-tight shut-off, thereby eliminating costs relative to this maintenance. Ready now in 2" ASA 900 and 1500.

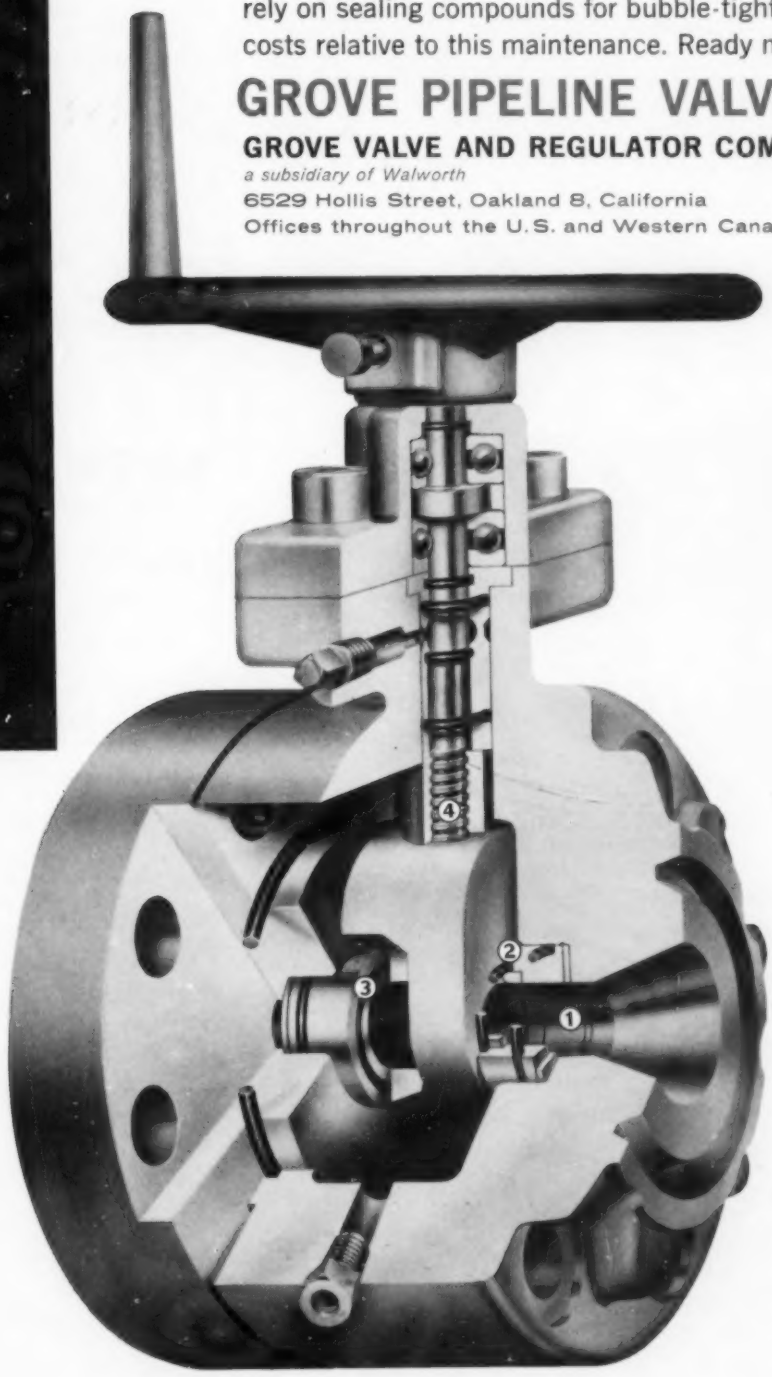
GROVE PIPELINE VALVES

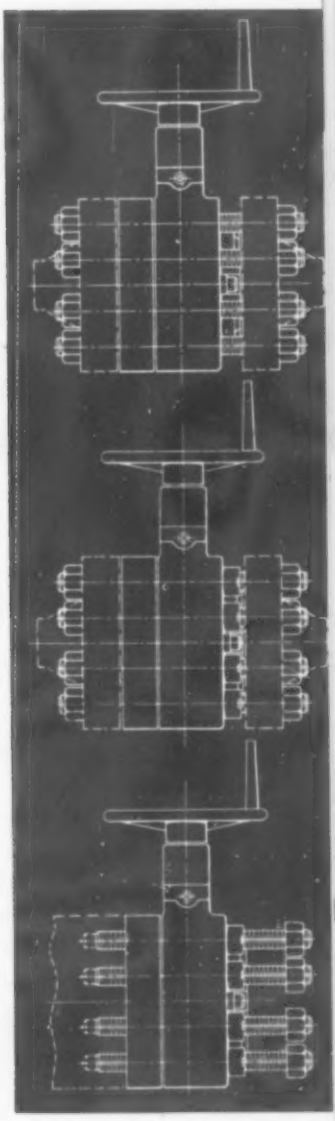
GROVE VALVE AND REGULATOR COMPANY

a subsidiary of Walworth

6529 Hollis Street, Oakland 8, California

Offices throughout the U.S. and Western Canada





7181

Quality pays

in a TRENCHER

AUBURN

IS BETTER BUILT TO GIVE YOU

MORE PERFORMANCE

You get more trench for your money—day in and day out—and at less cost with an AUBURN. Simple and rugged in design, it's virtually trouble-free. Its variable hydraulic drive automatically adjusts the speed to changing soil conditions. One man operates it digging up to 800' per hour, 6" to 14" wide and down to 6' deep.

Job proven . . . AUBURN is the first choice of contractors, utility and telephone companies throughout the world. It is the most profitable trencher you'll ever own, ask any AUBURN owner . . . he'll recommend it.

Write us for literature and the name of your nearest AUBURN dealer.

AUBURN MACHINE WORKS, INC

2065 South J Street, Auburn, Nebraska, U.S.A.

Phone: BRidge 4-3141

ANOTHER PIPELINE DOWN FOR KEEPS...

with Allan Edwards "heavyweight" concrete river weights . . . the most satisfactory way to hold a line in place for any river or swamp crossing.

SET-ON OR BOLT-ON WEIGHTS

For any size line . . . any crossing.

ON THE JOB CONSTRUCTION

Saves time and money on big jobs.

Check our complete line of pipeline specialties

HALFSOLES — WELDING SLEEVES

CONCRETE PIPELINE MARKER POSTS

*Write for free 16 pg. catalog.

Allan Edwards, Inc.

P.O. BOX 7218 — TULSA, OKLA.

butyl-polyethylene tape in 15 and 20-mil thicknesses.

Both tapes use a butyl base liquid primer for bonding purposes. Primer is applied at prevailing temperatures.

(This item supplements Plicoflex, Inc. data on page 329 of the Pipe Line Catalog, Third Revision.)

For more data, circle **No. E6** on Readers' Service Card, last page this issue.

Plugging Machine

A low-pressure plugging machine complete with welding fittings has been developed by T. D. Williamson, Inc. The Shortstopp plugging machine provides a quick and effective way to stop-off piping at working pressures up to 60 psi, and

temperatures up to 180° F. It can isolate a section of line for repairs, etc.; be used to relocate or extend lines; and other operations without interrupting the flow.

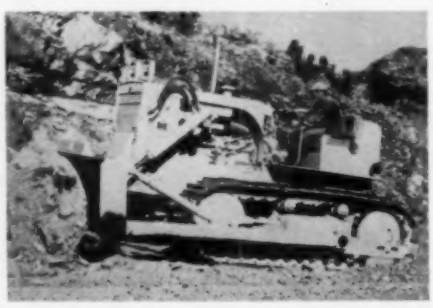
Sizes will range from 2 through 12 inch.

(This item supplements T. D. Williamson data on pages 573-576 of Pipe Line Catalog, Third Revision.)

For more data, circle **No. E7** on Readers' Service Card, last page this issue.

Intermediate Tractor

An intermediate size crawler tractor, TD-15 (151 series), has been introduced by International Harvester Company. With a six-cylinder D-554 diesel engine, the tractor develops 105 horsepower at 1,650 rpm. Drawbar hp is 85 and the unit has a 23,750-pound maximum drawbar pull. The four-cycle, valve-in head engine features in-built, gasoline conversion, push-button, all-weather starting. It has six speeds forward and reverse with a single stick shift.



For more data, circle **No. E8** on Readers' Service Card, last page this issue.

Dry Extinguishing Agent

A dry chemical extinguishing agent for A, B, and C fires, has been developed by Ansul Chemical Company. Labeled the "Foray," it is offered in a complete line of portable extinguishers. It can be obtained in three sizes in cartridge or stored pressure type extinguishers. With only a few modifications, the Foray extinguishers are the same as the D-Model line. Conversion kits are available. Models come in 8½-pound, 17-pound and 25-pound cartridges or store pressure type units.

For more data, circle **No. E9** on Readers' Service Card, last page this issue.

WALKER AND ASSOCIATES, INC.

Pipe Line Division

COMPLETE PIPE LINE ENGINEERING SERVICE

ENGINEERS – SURVEYORS
DRAFTSMEN

3400 Montrose - JA 6-2161

Houston 6, Texas

Write for Bulletin

PATENTED

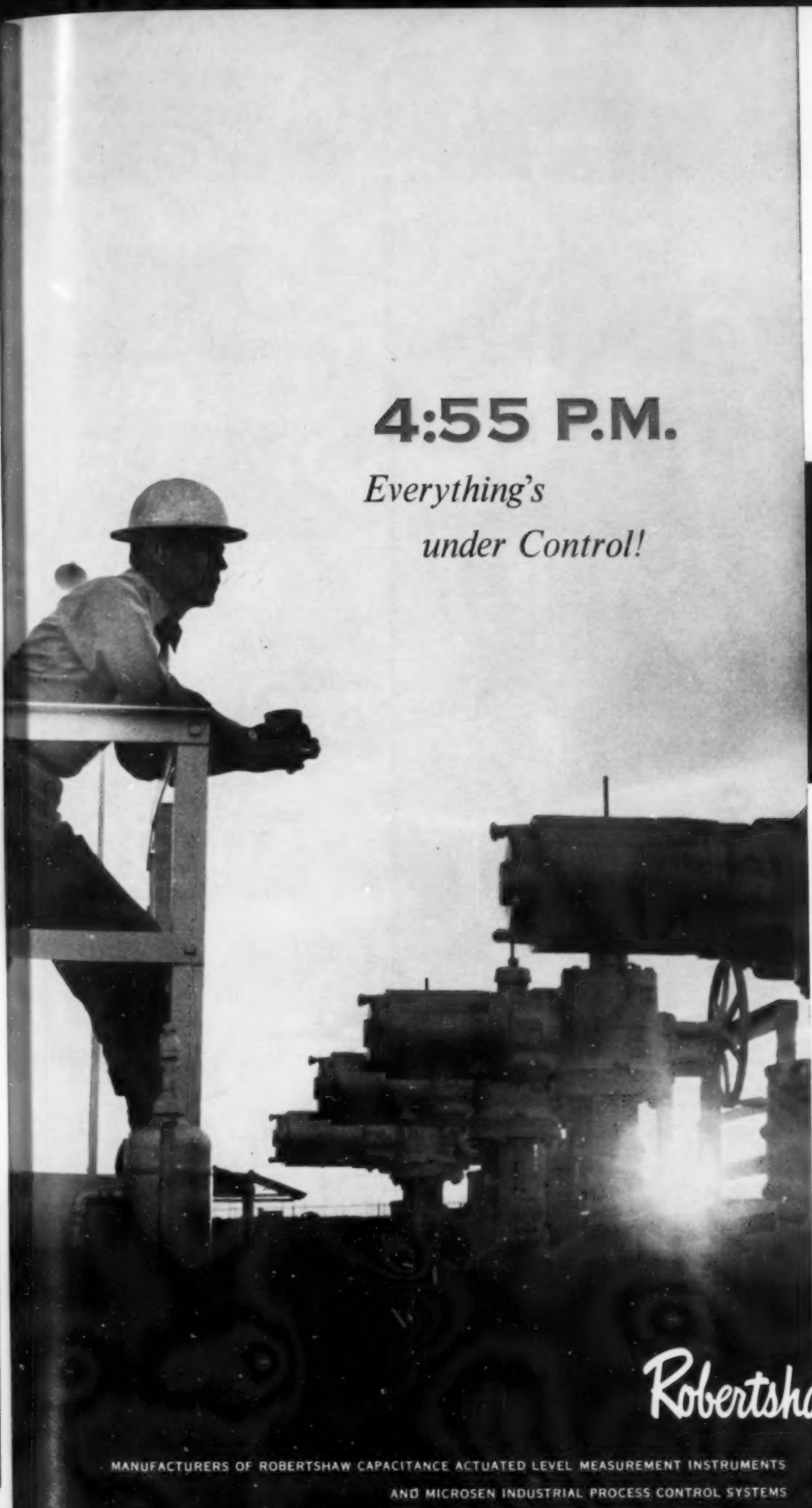
NAME OR EMBLEM

PIPE LINE GAS

PIPELINE VENTS AND MARKERS

FLEET-LINE CO.

P. O. BOX 276-K
SHREVEPORT
LOUISIANA



4:55 P.M.

Everything's under Control!

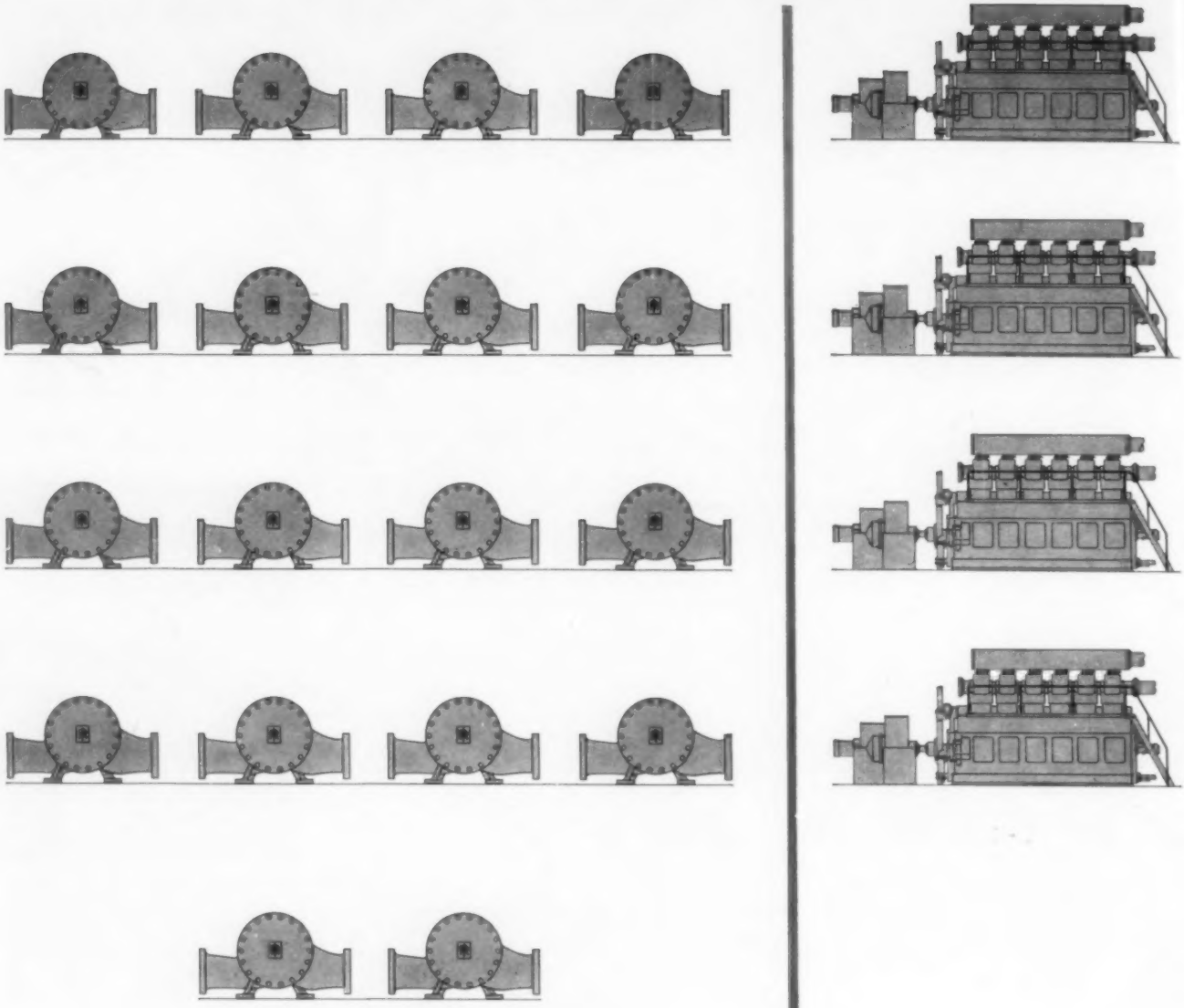
ROBERTSHAW'S VIBRASWITCH MALFUNCTION DETECTOR IS ON THE JOB!

In five minutes the only maintenance man at this remote pipeline pumping station will leave for the weekend. Everything's under control. On unattended automatic equipment . . . wherever expensive rotating and reciprocating machinery deserves 'round-the-clock malfunction protection . . . specify Vibraswitch. Electrical and pneumatic signaling models that react instantly to changes in acceleration of machinery vibration . . . shutting down, alarming, activating standbys. When will your expensive machinery next break down? How costly and time-consuming will repairs be? Can you afford to be without low-cost Vibraswitch protection? Over 50 conveniently located sales-service offices. Write for address of the one nearest you.

Robertshaw

MANUFACTURERS OF ROBERTSHAW CAPACITANCE ACTUATED LEVEL MEASUREMENT INSTRUMENTS AND MICROSEN INDUSTRIAL PROCESS CONTROL SYSTEMS

Aeronautical and Instrument Division, Robertshaw-Fulton Controls Company, Santa Ana Freeway at Euclid Avenue, Anaheim, California.

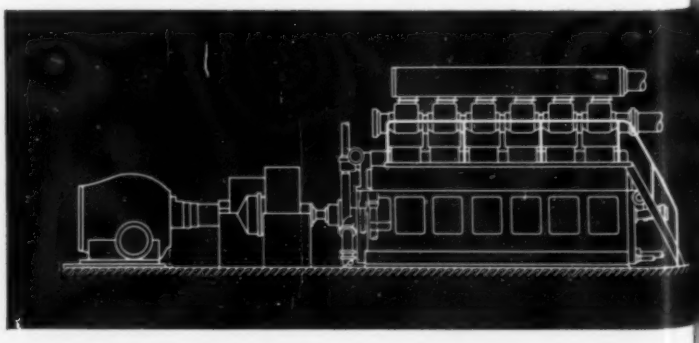


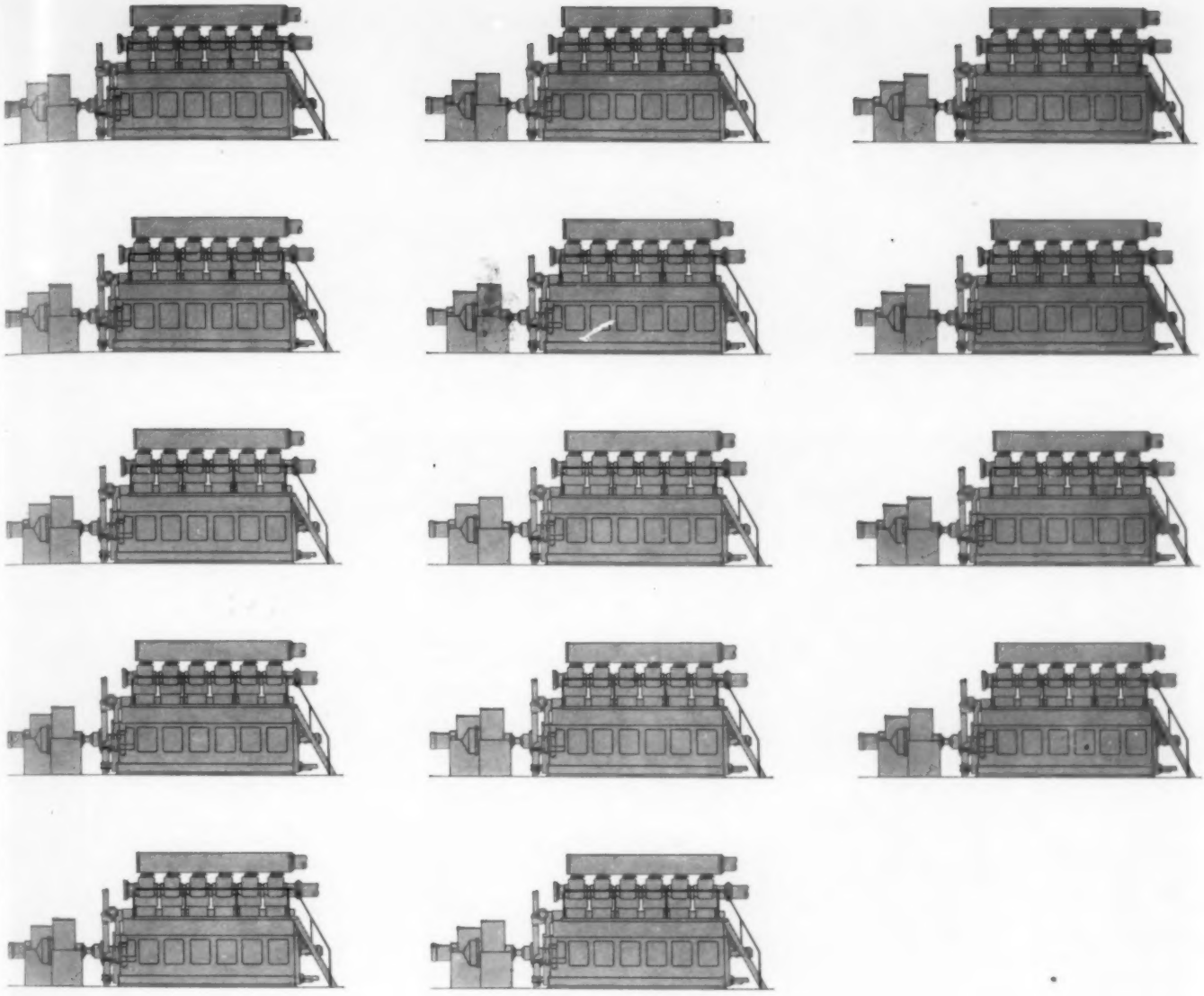
THIS MANY Ingersoll-Rand CDP centrifugal compressors

will give 495,000,000 cfd

through new PEMEX 490-mile

Each centrifugal pipeline compressor will be driven by a 12-cylinder, 3300-hp PKVT gas engine — precision-matched for top performance and economy. The units are arranged in series, and each will handle the full throughput.





and *THIS MANY* Ingersoll-Rand PKVT gas engines

of gas a 59,400-hp push

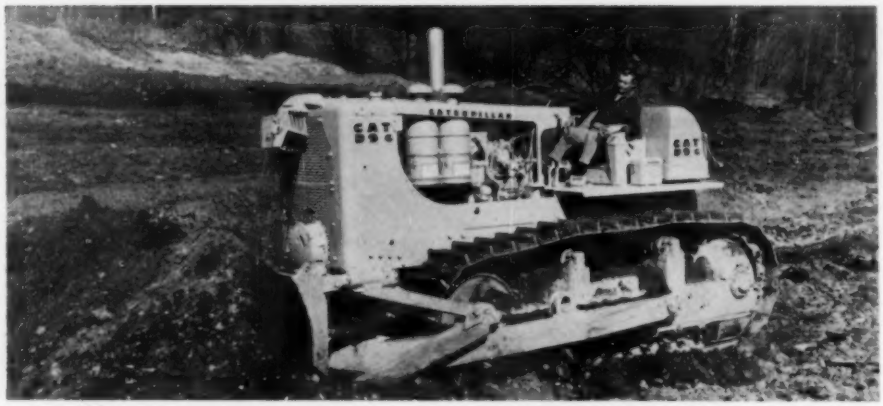
Tabasco-Mexico City pipeline.

Ingersoll-Rand

261 A 14

11 Broadway, New York 4, N.Y.

The World's Most Comprehensive Compressor Experience



Higher Horsepower

An increase by 15 percent in its crawler tractor along with basic improvements in power shift transmission are major advances incroporated in the Caterpillar Tractor Co. new series Cat D9G tractor.

Three new hydraulically boosted cable controls and arrangements of three different hydraulic controls improve overall versatility and adaptability of the unit. The 385 horsepower rating is achieved with a system of controlled turbocharging with aftercooling of intake air. This system provides air flow over a wide range of engine operations; quickly responds to need for more air as engine lugs and thereby increases torque available; and develops quicker acceleration by boosting air flow at part load conditions.

(This item supplements Caterpillar Tractor Co. data on pages 66-69 of the Pipe Line Catalog, Third Revision.)

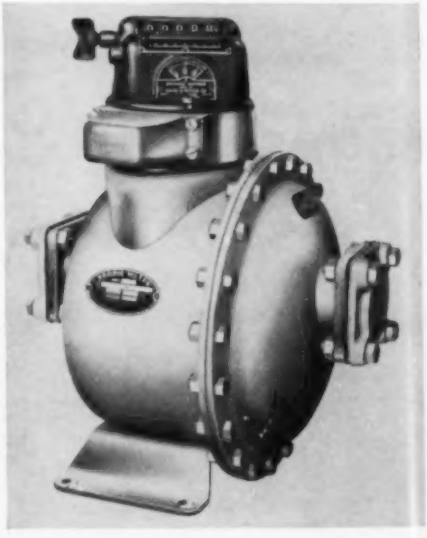
For more data, circle **No. E10** on Readers' Service Card, last page this issue.

Tone Multiplex

Tone multiplex equipment for data transmission, teletype, telemetering, contro and signalling functions is announced by Radio Corporation of America. The Type CT-42, transistorized equipment is suitable for wireline, carrier or microwave circuit use.

The equipment provides 24 tone channels between 420 and 3180 cycles which can be keyed at speeds up to 100 words per minute. All types of terminations for telemetering, data transmission, and control applications are available for use with the equipment.

For more data, circle **No. E11** on Readers' Service Card, last page this issue.



Liquid Meters

Two BiRotor Meters, designed to handle crude and refined petroleum products,

CUT FUEL COSTS
BILLS
$ $
NOISE CONTROL IS OUR BUSINESS
There is a Maxim Silencer for every industrial, marine or special purpose requirement.

UTILIZE WASTED EXHAUST HEAT!

Maxim Heat Recovery Silencers can save 1,000 or more BTU per hp / hour that you are now wasting through engine exhausts.

Many industrial plants, power stations and petro-chemical installations produce enough BTU's in wasted exhaust heat to handle a large part or all of their heat requirements. Maxim Waste Heat Recovery Silencers are especially designed to turn this BTU loss into usable energy as steam or hot water.

There are valuable heat recovery possibilities in most industrial plants. For these applications or wherever there is a need to control noise or sparks, there is a Maxim Silencer designed to do an efficient job for you. Look around your plant or field installation and see if you're paying high fuel bills and wasting more heat in exhaust than you're buying in heating fuel.

A Maxim engineer is ready to work with you on your heat recovery and noise control projects . . . write or call today!

MAXIM BEAIRD DIVISION

THE J. B. BEAIRD COMPANY

A subsidiary of American Machine & Foundry Company

Shreveport, Louisiana

Sales agents in all principal cities and in many foreign countries.

Los Angeles' New Jet Age Terminal

assures ***PERMANENT*** *Protection to Fuel Supply Pipelines at low cost—with*

SOMASTIC®

SOMASTIC pipe coating was selected for 80% of Los Angeles International Airport's new 200,000-foot refinery-to-aircraft underground fuel line system. SOMASTIC, with a 31-year history of success, gives lifetime assurance against repair or replacement of vital pipelines, particularly those under costly runways and fueling satellites.

SOMASTIC asphalt mastic pipe coating is non-conductive, moisture-proof, and resistant to soil stress and puncture. Because it resists corrosion as long as it remains in the earth, SOMASTIC is the *most economical* pipe coating you can obtain.

Write today for complete data on durable SOMASTIC.

PIPE LININGS Inc.

Subsidiary of American Pipe and Construction Co.

WILMINGTON, CALIF.
2414 E. 223rd St.
P.O. Box 497
SPruce 5-3273, TErminal 5-8201

MILPITAS, CALIF.
1350 Piper Drive
P.O. Box 25
AMherst 2-2770

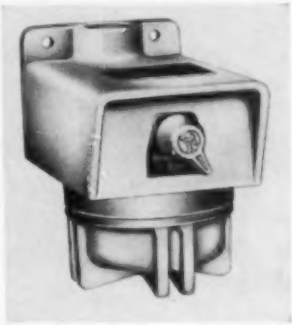
have been introduced by Ralph N. Brodie Company. The meters are particularly suitable for use on small loading racks, pipe lines, LACT units and similar application.

Both units have Brodie's double case construction and were developed as companion models. The 40D has an 80 gpm capacity and the 50D has a 120 gpm capacity; both units have 125 psi working pressure. In-line inlet and outlet connections are on both models.

For more data, circle **No. E12** on Readers' Service Card, last page this issue.

Wiring Protection

Shielded controls and threaded construction throughout provides unusual protection for relatively delicate wiring devices housed in these explosion-proof dust ignition-proof and water-tight fittings. The Pyle-National Company fittings



are identified as EW Series Pylets and are available with various standard wiring devices including tumbler switches, manual motor starters, push botton stations, selector switches and pilot lights.

Bodies are regularly tapped at top and botton for ½ to 1-inch conduit. Back and both sides can be tapped up to 1-inch when specified.

For more data, circle **No. E13** on Readers' Service Card, last page this issue.

TOGETHER FOR GOOD

Reilly Coal Tar Enamels and related primers, used together, provide the corrosion protection needed by underground metal structures. The Reilly hot enamel system is:

electrically insulated	oxidationproof
waterproof	stressproof
oilproof	tough and strong
bacteriaproof	permanently bonded

In addition, Reilly coating systems offer ultimate longevity because they inherit the chemical inertness and stability of coal tar, from which they are made.

Specify Reilly hot-applied coal tar enamels and related primers for oil, gas and water pipelines.

REILLY ENAMEL AND PRIMER

Reilly Pipeline Enamel	Reilly Pipeline Primer	Reilly Redhead® Primer
Reilly Intermediate Enamel	Reilly QD Primer	
Reilly 230-A Enamel	Reilly 230 X-10 Primer	
Reilly 230 AWWA Enamel	Reilly 230 X-10 Primer	
Reilly Hot Service Enamel	Reilly 230 X-10 Primer	

REILLY TAR & CHEMICAL CORP.
1615 MERCHANTS BANK BUILDING, INDIANAPOLIS 4, INDIANA

Reilly COAL TAR PRODUCTS
ARMEX Protective Coatings

Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Readers' Service postcards just inside the back cover and facing the Advertisers' Index. Simply circle code numbers of items desired—sign and mail card.

Welding Pipe Line

Welding of pipe lines and piping systems is covered in Lincoln Electric Company bulletin recently published. Hand welding techniques are described for depositing sound welds vertical up or down with pipe axis in vertical or horizontal positions.

Details on full automatic submerged arc welding are also presented. API pipe specifications, analysis, and physical properties are reviewed and charts on pounds of electrode consumed per joint for various size pipe is included.

To get a copy, circle **No. E14** on Readers' Service Card, last page this issue.

Compressors and Pumps

Corblin diaphragm-type compressors and pumps are described in bulletin 4074 issued by American Instrument Company, Inc.

Designed for compression without contamination, the units' features also include leak-free design; high compression ratio; and reduced maintenance costs. Compressor applications include gas transportation and storage.

To get a copy, circle **No. E15** on Readers' Service Card, last page this issue.

Engine Control

Robertshaw-Fulton Controls Company has published a catalog on Controls for Engine and Turbines and a bulletin on pneumatic engine control system.

Information is given in the bulletin on start/stop functions, safety shutdown and alarm and/warning signal.

To get a copy, circle **No. E16** on Readers' Service Card, last page this issue.

Research

Battelle Memorial Institute has published a descriptive statement on "The Administrative Controls of Contract Research for Industry."

It describes the balance of administrative controls between the sponsor of a project and the research institute engaged, under contract, to conduct the study. It points out that the sponsor retains basic control over the objective, scope, timing and costs of research but is relieved of technological administration. This is one of a series of statements on procedures and characteristics of contract research for industry.

To get a copy, circle **No. E17** on Readers' Service Card, last page this issue.

Special report to users of Cat D6 and D7 track parts

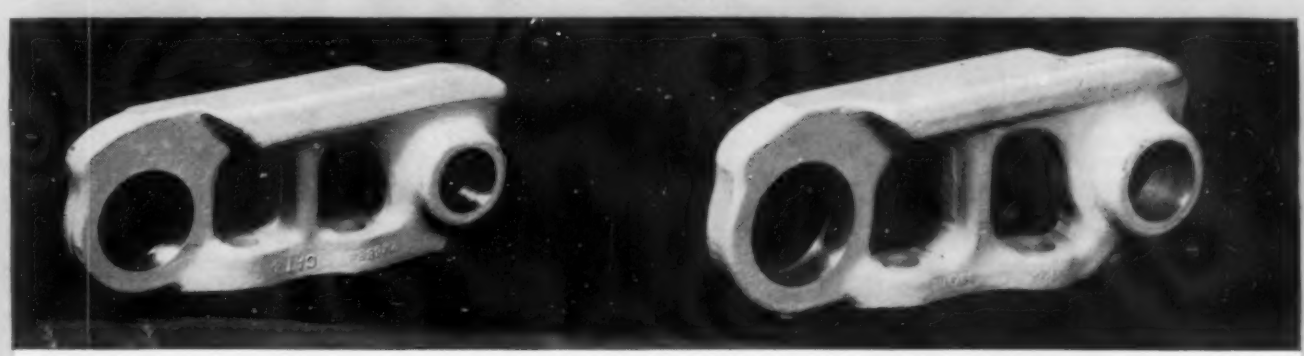
CAT CATERPILLAR

Parts you can trust
... cost less per hour

Up to 25% Longer Link Life at No Increase in Cost

New track links have rails hardened deeper than any other brand . . . hardness with file-like, wear-resistant qualities

You can't "see" metallurgy and heat treatment in track links. But you'll definitely see the *results* in the extra life you get from the *new* Cat D6 and D7 track links. These superior links will outlast all other brands yet the suggested price is no higher than before.



D6, 955 AND 561 LINKS

- "Hi-Electro" hardened rails give outstanding wear life.
- Rail wear cases are twice as deep as other brands.
- Closer bore tolerances retain pins and bushings better.
- Full 1¼" top rail surface to pin boss clearance allows more wear before roller flange contact.

D7, 977 AND 572 LINKS

- 12% thicker rails eliminate peening, rebuilding distortion.
- 32% thicker struts and more steel in critical areas increase over-all strength, resist cracking.
- File-hard "Hi-Electro" hardened rails withstand abrasive wear.
- Uniform, wear-resistant rail cases deeper than other makes.

These new track links are made from special steel, carefully pretested *before* manufacture. They're forged, machined and heat treated to develop maximum strength and toughness. A non-peenable wear barrier is induced *deeply* into rail top and sides by exclusive "Hi-Electro" hardening. This exacting heat treatment permits maximum, file-like wear resistance without brittleness.

Try the new links . . . and the many other *special-purpose* tractor undercarriage parts, all designed and built to keep your cost-per-hour to a minimum. Cat undercarriage specialists can help you select right combinations and give you money-saving recommendations tailored to your particular needs. It's all a part of your Dealer's Custom Track Service . . . the practical approach to lowering undercarriage costs by extending part life and machine availability through proper parts selection and parts care.

Etched rail cross-section shows deep, uniform wear case found on top and sides of new links.

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Caterpillar Tractor Co., General Offices,
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at joint where pipe is screwed into fitting

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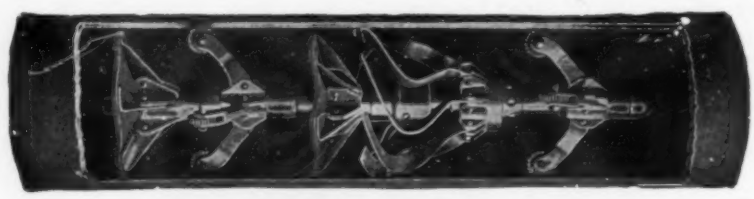

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Partly compressed guide arms and knives are held tight but flexible against pipe walls by pressure of individual springs. Guide arms keep scraper in line, eliminating undue driver wear and prevents cocking. Flexibility permits Go-Devil to round bends.

Go-Devil

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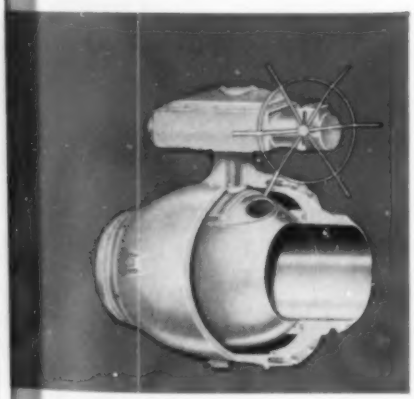

in for life: Once you weld a Rockwell Hypresphere valve into your pipeline, it's in for life —you'll never need to see the inside again. The seats in these spherical, full-opening valves are renewable forever, without taking the valve apart. And you know that today, tomorrow or any time in the lifetime of the line you need quick, sure shut-off, you'll get it with Hyprespheres. We'll be happy to send you complete information.

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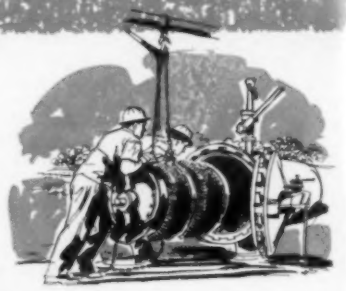
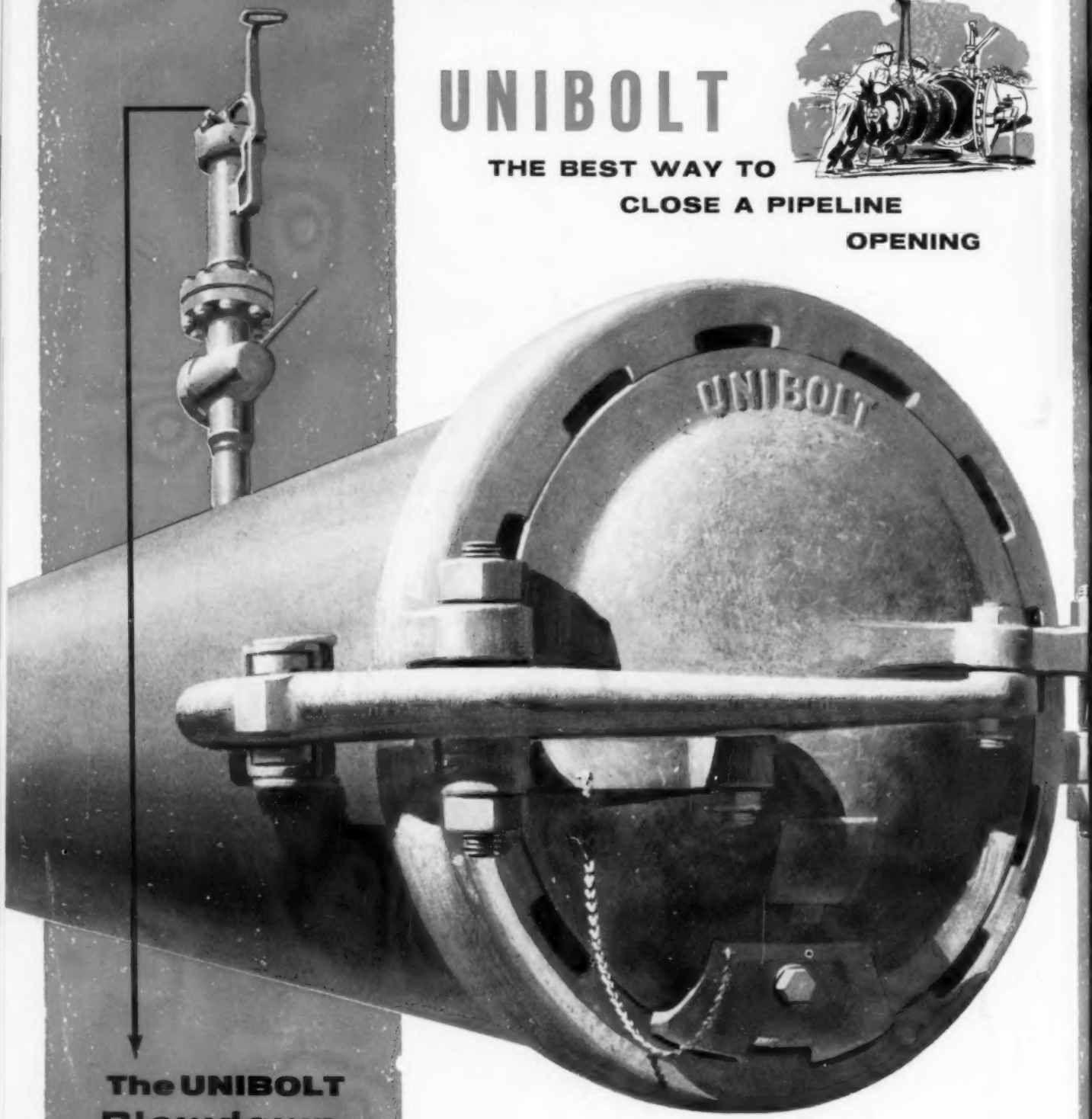


UNIBOLT

THE BEST WAY TO CLOSE A PIPELINE OPENING



The UNIBOLT Blowdown

is equipped with a UNIBOLT Closure on a cantilever hinge for easy opening. A bleeder plug is provided for safely relieving pressure that may leak thru the riser valve.

UNIBOLT Hinged Scraper Trap Closures are easier to open—only two bolts to release. No heavy lifting, nothing to fall on workmen. They are the safest of all closures. The nut-lock must be released before the closure can be opened, and releasing the nut-lock automatically bleeds off any pressure that may be trapped in the line. They swing open and shut on a sturdy hinge. An oil-resistant, resilient, self-sealing gasket provides a pressure-tight seal and seldom, if ever needs replacement. Overtightening the closure bolts cannot damage the gasket.

Complete details and specifications on these and other UNIBOLT products for the pipeliner are carried in Bulletin PL-600, a copy of which will be sent on request.

UNIBOLT

THORNHILL CRAVER CO.

P. O. Box 1184, Houston, Texas